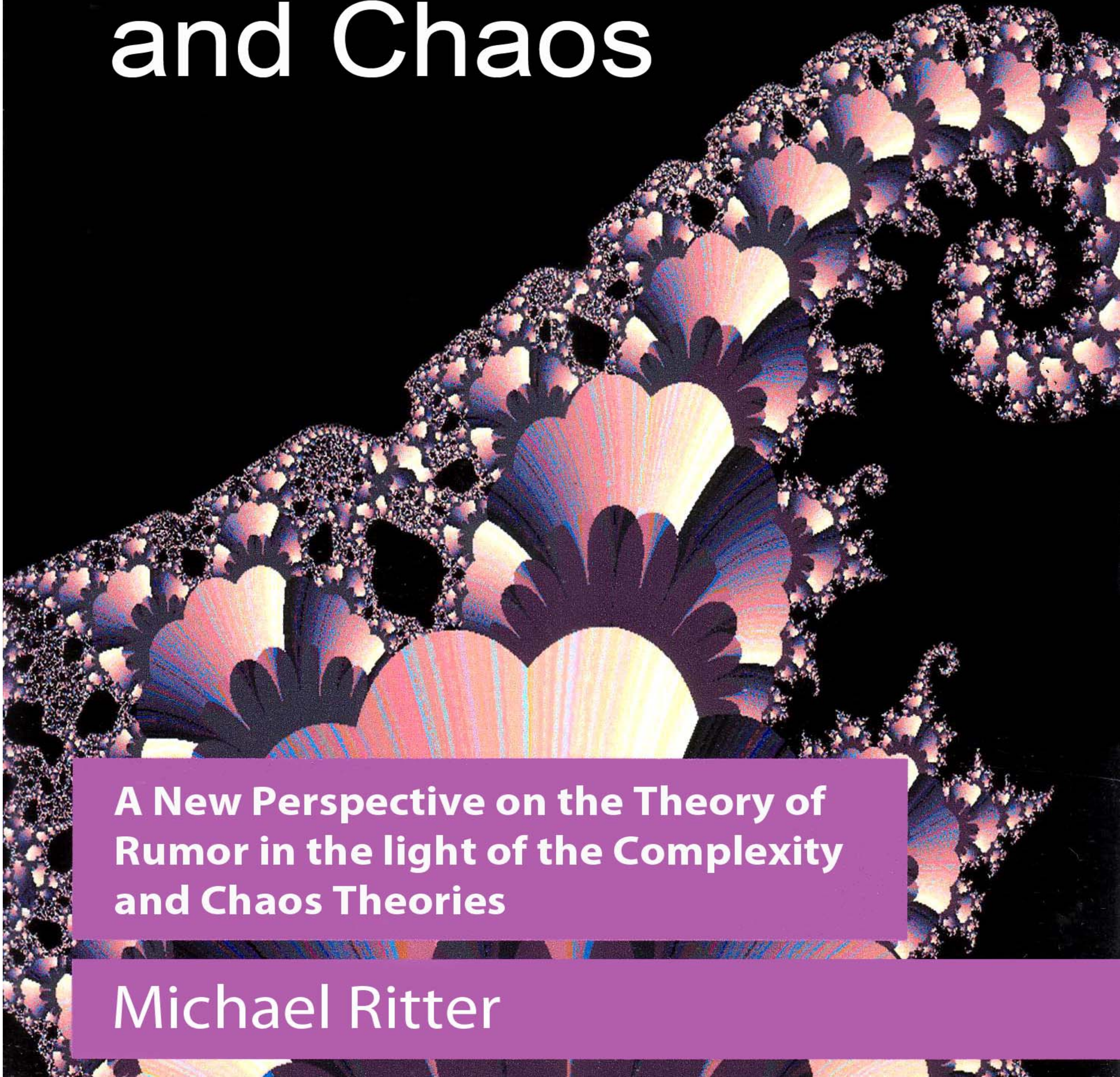
Rumor and Chaos



A New Perspective on the Theory of Rumor in the light of the Complexity and Chaos Theories

Michael Ritter

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Introduction

According to some authors, the history of sciences in the 20th century will remain in the minds of future generations thanks to three formulations: the Theory of Relativity, Quantum Mechanics and the Chaos Theory.

Chaos research, from the point of view of Prigogine and others, is the third big revolution of the current century in the field of natural sciences. In the same way as the others, the Chaos Theory spreads doubt on the very scaffold of the whole Newtonian physics.
While the theory of relativity ended with the time-space illusion as two absolute categories in Newtonian physics, and the theory of quantum mechanics ended with the Newtonian dream of accurately controlled measurement processes, the Chaos Theory completely eliminates Laplace´s utopia of deterministic prediction. However, of these three revolutions, chaos considers the universe both a physical and visible object as well as the object of what is essentially human in itself (Gleick, 1987).
In this respect, the Chaos Theory represents a change of paradigm for the sciences (Kuhn, 1976).

In classical physics, the basic concern is on the need and desire to measure processes and movements on an ongoing basis ("measurement of the future"). From this classical point of view, randomness resides in mankind's ignorance (mechanical world). The Chaos Theory is based on the fact that dynamical systems contain predictability and random processes (random = underlying indetermination) (Roland, 1997).

Complex systems have been considered in an erroneous manner for a long time. The starting point was that complexity was solely an overlapping of several processes, of simple unity and therefore, only due to practical reasons, it was impossible to understand the behavior of complex systems.
As from the appearance of chaos research (Lorenz, 1961), chaos is being analyzed as a "complex and dynamical arrangement of elements which compose a unified whole, the behavior of which is both unpredictable (chaotic) and patterned (orderly) at the same time" (Gell-Mann, 1985). The science of chaos is that of such chaotic and orderly behavior.

Formally, the chaos theory is defined as the study of complex, dynamical nonlinear systems. Complexity implies just that. Non-linearity implies recurrence, iteration and mathematical algorithms of higher level; and dynamical means non-constant and non-periodical. However, chaos and complexity are not the same. While chaos is the study of how simple systems can generate complex behavior, complexity studies how complex systems can generate simple behavior. They are two sides of the same coin.
There are several mistaken concepts about the chaos theory. The most frequent is the one that links chaos to disorder. Nothing could be further from the truth! The chaos theory has nothing to do with disorder. It neither disproves determinism nor purports the impossibility of order in systems. It neither invalidates the empirical evidence or claims that modeling complex systems is useless. "Chaos" in the chaos theory is order –not order from the classical semantic point of view but the actual essence of order.

Basically, the chaos theory tells us that a minor change, a minor modification can bring about huge fluctuations in the system. One of the core concepts is that, although it is

impossible to accurately predict the future state of a system, it is generally possible to establish its behavior in a holistic model.

In this way, the chaos theory lays emphasis not on the disorder of the system –its inherent unpredictability- but on its inherent order, i.e. the universal behavior of similar systems.

In his book "A Brief History of Time" (1988), Stephen Hawking predicts that we are near the end of science. Ilya Prigogine, at a lecture in the University of Illinois in 1994, answered that "we are not at the end of science, but at the beginning of a new science of love". He referred to the science of complex systems, the study of how things work in our universe.

Unlike what happens in the field of quantum mechanics, there is an attempt to apply the science of chaos to several events directly related to the frequent human experience; thus explaining such different phenomena from heart arrhythmia to economic aspects such as the Stock Exchange fluctuations, to the start of life on the earth; in addition to the behavior of dynamical physical systems with a high number of components, i.e. atmosphere or a liquid in turbulent state (Sametband, 1994). Therefore, the four hundred year old study of chaos is a new and highly promising way of applying known laws of physics -with the fundamental help of computers- not only to biological and economic sciences, but to social sciences, to the extent that they focus on the social aspect in the light of complex dynamical systems.

It is in the field of social sciences where the state of the art application of the chaos theory is however only in the bud. Some researchers from social psychology, for example, have reached the conclusion that the chaos theory represents an alternative vision of the discourse prevailing in scientific psychology, where researchers are mainly concerned about predictability of phenomena based -to a great extent- on linear relation tests. In turn, in the light of the chaos theory, they analyze the nature -dependent on time and evolution- of experience and social interaction through the methodology of the non-linear dynamical systems (Ball, Carr and Watters, 1996).

As per sociology, the chaos theory provides an elegant mathematical foundation for social science that asserts variety and change as completely natural features of social systems. Non-linear dynamics outline symbolic interaction and reveal patterns in, for example, criminality, morality, voting as well as the greater transformations of human history (Young 1991, 1993 and 1994).

In the scientific community dedicated to the study of the social communication processes, the application of the complexity and chaos theories has not yet caught on, although those based on linear models of communication do not actually explain the multi-channeled dynamic - sometimes chaotic - medium for human communication. On the other hand, unpredictable behavior, interaction and feedback loops, decentralized decision making processes and the interdependence of various simple systems, configure a complex system. This is twofold: individuals create complexity when they resort to syntax (rules, codes or symbols) to translate semantics (meaning), and action is connected with an actor (simple system) in the same way that communication is related to a social network (complex system).

Within this framework it turns out to be particularly interesting to approach the phenomenon of rumor in the light of the chaos theory. On the one hand, rumor has been one of the least analyzed communicational facts, both at the interpersonal and media

levels since social communication appeared in the world of science. On the other hand, rumor is undoubtedly a dynamical system par excellence, highly complex and basically non-linear. These are conditions, as explained above, to be met by systems in order to be the object of analysis within the framework of the complexity and chaos theories.

Now, if this is so, it is worth investigating which are the contributions of this new vision of science on rumor. For starters, an analysis of the rumor as transmission system is appropriate as well as -and in my opinion most importantly- the verification of patterns in the content, in the discourse of rumor.

The chaos theory does not study the causes (Newtonian physics) but the patterns which are being produced, and these are the object of our analysis.

The first chapter of this paper starts with the existing literature on the rumor and the position of different schools of social sciences related to it. The analysis of four cases of different characteristics in the second chapter aims at highlighting certain basic qualities of rumors as explained in the first part.

Chapter three briefly describes the complexity and chaos theories. It does not aim at being a treaty in itself on the topic but a superficial introduction on a relatively new subject, necessary to understand the final chapter. This last chapter is intended to apply the concepts and basic principles of the complexity and chaos theories to the phenomenon of the rumor in order to observe it, as indicated by the title of the book, in the light of a new and innovative perspective.

José Luis Romero, an Argentine historian, once said that “one of the biggest difficulties that the scholar faces to understand new phenomena or processes stems from the use of dated or inadequate conceptual instruments”. This quotation comes to mind since this paper is intended to show that an alternative theoretical approach from the chaos theory offers a viable base to develop the understanding of the rumor and can provide identification and evaluation frameworks of its patterns behavior.

It is clear that the goal set, in view of the lack of references and previous studies in this field, is a daring though attractive hypothesis. Its analysis must be conducted with a critical eye, but as long as it responds to reality, it may become an interesting starting point for numerous future analyses and reflections.

First Part: The Theory of Rumor

"I have found the people strangely fantasied;
Possess'd with rumours, full of idle dreams,
Not knowing what they fear, but full of fear"
William Shakespeare (King John)

"The monstrous bird with as many eyes, lips and tongues as feathers has freed itself and the beast cannot be controlled"
Virgil (Aeneid)

1 The Theory of Rumor

They are intangible though omnipresent. They poison the environment but even the most radical environmentalists frequently resort to them.
They often interfere -sensibly and subversively- in social relationships and immensely influence the stock market and politics.
They are employed as dangerous weapons in market competition, elections and power struggles. In fact, although they have caused more than one war, they have practically been left untouched by research. They are the rumors.
Rumors go through the entire society and signal the social reality. They create groups that transmit, regenerate and modify them to fill the communication void. They ensure social cohesion, warrant respect of limits towards others and towards power and convey meaning to the unknown, the incomprehensible and the mysterious.

They are often put on stage without measuring their consequences and they multiply without any type of control, chaotically. Nothing is more attractive to the public opinion than a rumor revealing some secret, interpreting some information, narrating something suspicious or anticipating a fact. Rumors are hard to stop or prevent. In general their life is ephemeral, they catch our attention, they spread like wildfire and they rapidly become exhausted -unless they are regenerated- because the objective in itself is the very here and now. This is closely related to the mass media, which equally appeal to the collective attention and constantly demand new and innovative announcements. When formal channels transmit rumors, we talk about false information or news, not rumors, as if the public opinion's attention to the media depended on completely different laws[1]. However, differentiating between rumors and information proves difficult, because they both come from someone we rely on, the "warrantor", and we are unable to show or prove their truthfulness.

1.1 The State of Research

Considering the effect and transcendence of rumors, it would be logical to suppose that there is research available on this phenomenon in all fields of social sciences, such as history, sociology, political sciences, ethnology, experimental and social psychology or social communication. However, it is not the case. Research conducted on rumor is scarce. It is hard to provide a reason for this. Perhaps the evasive and ephemeral nature of rumors and the fact that, in most cases they are not remembered, have been the reasons why researchers have deviated their attention to other poles of attraction [2].

(Many of the notes correspond to texts in Spanish. English versions of those texts are most likely available)

[1] K. Young et al, *La Opinión Pública y la Propaganda.* (Buenos Aires, Editorial Paidos, 1991)

[2] "Our knowledge about rumors - their nature, causes and function - remains extremely limited. The research that has been done in this area is deficient or at least restrictive, in a number of respects." Terry Ann Knopf, *Rumors, Race and Riots* (New Jersey, Transaction Books, 1975), page 11

The first research on this phenomenon was based on “war rumors”. In September 1942, Robert Knapp[3] collected and classified 1089 rumors. They were recorded by the Massachusetts Committee on Public Safety with the help of Reader's Digest publishing company, which asked readers to send any rumor heard in the month.
While serving in the U.S. Armed Forces, Theodore Caplow[4] helped prepare an intelligence monthly report, which included a section about outstanding rumors. Caplow´s analysis referred to content, frequency, accuracy and truthfulness of rumors spread in every body of the U.S. Army.

Gordon Allport and Leo Postman are other researchers who have focused their studies on different aspects of the rumor. Their work *The Psychology of Rumor*[5], published in 1947 is still -50 years after its publication- a classic on the matter. Some years later, other authors questioned their methodology. They specially criticized lab artificial processes as opposed to the natural process of rumor which takes place in the social network; the arbitrary chain of senders and recipients as opposed to the spontaneous flow of actual rumors; the complex and violent nature of the stimulating object (such as battles and riots) and finally the profile of researchers who, since they come from psychology, tend to regard rumor as a phenomenon not focused on the collective but on the individual (Schall, Levy and Tresselt 1950; Defleur 1962; Buckner 1965).

Although serial or chained transmission is essential to analyze rumor, it is just one aspect of the research. Origin, content, frequency, diffusion, transmission and truthfulness of the rumor, as well as its prevention and control are equally important aspects not attended by researchers until Shibutani[6] and Kapferer´s[7] works appeared (1966 and 1987, respectively).

Another problem is that rumors have not been analyzed systematically. In his work *Improvised News, a Sociological Study of Rumors*[8], Tamotsu Shibutani examines 60 situations that gave rise to 471 rumors. In her book *Rumors, Race and Riots*, Terry Ann Knopf criticizes the lack of standardization of those cases analyzed by Shibutani. She points out such disparity as the Achilles' heel of his field study[9]. Shibutani selects events

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[3] Robert H. Knapp, “Psychology of Rumor”, *Public Opinion Quarterly* (vol. 8 Nº1, 1944) page 22; cited by Terry Ann Knopf, *Rumors, Race and Riots*, page 11

[4] Theodore Caplow, “Rumors in War”, *Social Forces*, vol. 25, Nº3 (March, 1947), pages 298-302; cited by Terry Ann Knopf, *Rumors, Race and Riots*, page 12

[5] G.W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947), page 12

[6] Tamotsu Shibutani, *Improvised News, A Sociological Study of Rumor* (Indianapolis- New York, The Bobbs-Merrill Co Inc, 1966)

[7] Jean Noël Kapferer, *Rumores: el Medio de Difusión más Antiguo del Mundo* (Barcelona, Plaza y Janes Editores, 1989, Spanish translation by Alberto Magnet)

[8] Tamotsu Shibutani, *Improvised News, A Sociological Study of Rumor* (Indianapolis- New York, The Bobbs-Merrill Co Inc, 1966), pages 26-27/ 215; also cited by Terry Ann Knopf, *Rumors, Race and Riots*, page 14

[9] “Another problem is that rumors have not always been studied systematically. For his book *Improvised News*, Tamotsu Shibutani examined 60 situations on which some 471 rumor developed. The material, however, was not standardized in any particular way. Hopscotching his way through history, the author

taking place at very different times, e.g. 1789 or 1963, or physically located in remote places, e.g. Hawaii, Hiroshima or Harlem, or such different facts, as Mexican terrorism through kidnappings, Cromwell´s massacre in Ireland, an explosion in Canada, the execution of a Japanese general or the Chicago's race demonstration in 1918. The author, who openly admits that his sources lack high and uniform quality and that his examples are not representative, expresses that his objective was only to “build a hypothesis rather than verify it”[10].

By building a different conceptual framework, Knopf has extracted the rumor from the lab, placed it in the real world and systematized it. She has managed to do so by isolating a specific type of rumor in operation and within a specific framework.
In *Rumors, Race and Riots*[11], the author focuses solely on the issue of racism. The content of the rumors she analyzed -either directly or indirectly- refers to events, topics, actions or activities performed by individuals -either white or colored- as part of a certain race group. On the other hand, the rumors included are limited to the context of social conflicts (civil disorders). Sociologist Fredrik Koenig[12], from Tulane University, has also based his research on a specific type of rumor but in his case, the rumors in question are corporate.

1.1.1 The Psychological Model

1.1.1.1 The Gestalt Perspective

According to the *Gestalt Theory*, as soon as a perception occurs, forces tending to memory re-organization start to operate.
Alexius Meinong von Handschuchscheim, Carl von Ehrenfels and Sigmund Witasek first stated the Gestalt Theory in the 1920´s at the Austrian School of Graz; Karl Koftka, Wilhelm Köhler and M. Wertheimer, School of Berlin, further developed it from a more radical perspective. The Gestaltic essence is summarized in the motto *the behavior of the whole is not determined by that of its individual elements* (it also synthesizes the General Theory of Systems, as will be discussed in the third part).
This school considers psychic processes unified sets instead of addition of activities or separated elements. The different components of personality are interrelated, so that the variations in a certain scope result in changes in adjacent regions. According to this theory, all the objective physical characteristics of the stimulus cannot be reproduced in the initial act of perception. First, perception has a selective nature and tends to simplify the surrounding world. Then, memory continues and activates the process. Free from the restrained influence of the present stimulus, memory accelerates the formation of proper

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selects one incidents (randomly)...”. Terry Ann Knopf, *Rumors, Race and Riots* (New Jersey, Transaction Books, 1975), page 13

[10] Shibutani, *op. cit.*, Page VII

[11] Knopf, *op. cit.* Page 15

[12] Fredrick Koenig, *Rumor in the Marketplace: The Social Psychology of Commercial Hearsay* (London, Auburn House Publishing Company, 1985), page 5

configurations (gute Gestalten). The change tends to simplification, symmetry, to a pleasing configuration[13].

Based on the Gestalt Theory and according to the reciprocal influence of cognitive and emotional processes that evidently occur in the changes suffered by the stimulus during transmission, Allport and Postman claim to have determined characteristics of cognitive assimilation. When asked about the factors that gravitate in the elimination or exaggeration of certain details involved in the rumor and about the transpositions, the contributions and other denaturalizing processes prevailing in the course of rumor, the authors respond that the answer is the assimilation process, the powerful attraction force influencing the rumor by the intellectual and emotional context pre-existing in the receptor's mind. It is worth mentioning that both authors determined that as rumor circulates, it tends to get shorter, more concise, easier to grasp and narrate. It loses words and details along successive versions.
The curve resulting from 11 experiments showed that during the course of five or six mouth to mouth transmissions -i.e. with no time interval between each other- approximately 70% of details are lost. This percentage is higher in the first reproductions.

1.1.1.1.1 Assimilation

Assimilation is the characteristic by which the details of rumor are stressed or leveled according to the demands of the main motivation of the story; these details also distort the story so that it becomes more consistent, more plausible and more *rounded*. In this way, objects not related to the story are eliminated since they would not *fit*. Thus creation of a confusing Gestalt is avoided and the story is as it *should be*.
During the process of stressing and assimilation of rumor, there appears a tendency to reach a conclusion. Therefore, the individual always tries to complete what is not complete in the field of the stimulus. *Good continuation* is the name given by Allport and Postman to this characteristic[14].

Condensed assimilation derives from the fact that apparently our memory tends to keep overload at the minimum level. Instead of remembering unconnected details, it is more economical to put them together and include them in one general category. As a result, what appears similar and is shared by a series of details is stressed whereas specific or particular features and differences, are lost.

Condensed assimilation explains the *clichés* or *patterns* resulting from oversimplification, i.e. the interest in economizing on mental effort. Rumor is not concerned about subtle differentiation. Referring to a *fat man*, a *group of people*, a *politician*, etc. is enough. A shared liaison or similar characteristic is established with prejudices, as shown in the fourth part of this paper.

[13] “In general, people schematize their memories more than they elaborate on them. The same tendency is observed in the case of rumors”. G.W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947), page 107

[14] G.W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947), page 106-120

Beyond the changes that help strengthen the core issue, numerous details shape themselves to refer to the mental habits rooted in the agent. Things are perceived and remembered according to the way one is used to regard them. Allport and Postman call this *assimilation to expectation*.

Assimilation to linguistic habits occurs when the subject's expectation boils down to the interpolation of the information perceived and remembered to pre-existent verbal clichés.
A fundamental step for adapting rumor to what is conventional and standard is the powerful effect of words when evoking images in the recipient and fixing categories within which he is to frame the event in his mind. Many rumors are spread almost exclusively thanks to verbal clichés. In most of them, it is easy to notice common places or contemptuous or derogatory phrases such as *black* (for individuals of dark complexion) or *cabby* for the cab driver, etc.
The interest in clothing detected by Allport and Postman in their research, drove them to point out that this characteristic of *assimilation to interest in clothing* is in itself something recurrent in women. Despite the authors' theory, it would be worth noticing that this is not about rumors but gossip which possess some different characteristics, as shown later.
Assimilation to professional interest and self-interest are two characteristics about the psychosocial environment of the individual who will be alert to those rumors that have to do with such topics.

Assimilation to prejudice was expressed in 50% of all the experiments conducted by Postman and Allport[15]; it determines the creation, re-creation or deformation of rumors according to the prejudices of the transmitters.

Based on the various gestaltic assimilation characteristics briefly described, the two American authors concluded that *most rumors start by narrating a real episode, i.e. from the perceived experience of an event lived by someone who considers it is interesting and important enough to communicate it to his peers*.

In virtue of the research in works by authors such as Shibutani[16], Knopf[17] and especially Kapferer[18], it would be necessary to correct the premise that rumors necessarily stem from a real episode. This alleged "reality" could have been attributed to someone by someone else. A typical case is that of urban legends.
Allport and Postman believe that in general, the key topic of the narration is perpetuated. An anti-Semitic story remains anti-Semitic and a horror story is still a horror story. The unwillingness to change the main topic was observed by Hartgenbusch[19] in his experiments, in which the anecdote and sentence in rumors were reproduced by a

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[15] G.W. Allport and Leo Postman, *op. cit.*, page 116

[16] Tamotsu Shibutani, *Improvised News, A Sociological Study of Rumor* (Indianapolis- New York, The Bobbs-Merrill Co Inc, 1966)

[17] Terry Ann Knopf, *Rumors, Race and Riots* (New Jersey, Transaction Books, 1975)

[18] Jean-Noël Kapferer, *Rumors: Uses, Interpretations & Images* (New Brunswick and London, Transaction Publishers, 1990)

[19] H. G. Hartgenbusch, "Untersuchungen zur Psychologie der Wiedererzählung und des Gerüchts" *Psychologische Forschung* Nr.18, 1933.

succession of individuals of different age groups and education levels. According to him, neither the content of the story nor the individuals who spread the rumor is important. The key topic will always remain the least susceptible to change. Although schematized and extraordinarily out of proportion, terminal stories in Hartgenbuch's experiment were always related to the starting element in the rumor content.

1.1.1.2 Freudian Perspective

From the Freudian psychoanalytical perspective, rumor generation can be analyzed from the operationality of the self.
In order to understand this approach, it is necessary to introduce first a brief explanation of Freud's theory: Sigmund Freud[20] found that the analysis of the conscious mind was not enough to understand the motivation of human behavior. He compared the mind to an iceberg, where the smallest and visible portion is the area of the conscious mind and the largest portion under the water is the area of the unconscious. According to him, compelling forces reside in the unconscious and dominate the individuals' thinking and actions.
Freud explored the unconscious for forty years and mapped the topography of relationships.
In his *Second Theory of the Psyche*[21], he expressed that personality comprises three systems: the id, the ego and the superego. Each one has its own functions, characteristics, components, mechanisms and operational principles. However, system interactions only occur under tension conditions.
The id constitutes the driving pole of personality (the original term in German is Trieb). Its content and expression are unconscious; part of them is inherited and inborn, part is suppressed and acquired. It is the primary reservoir of the psychic energy. From the dynamic point of view, there is conflict between the id, the ego and the superego. In the id, there are no moral restraints, there are only desires, impulses, drives: the principles of life, death, self-preservation and sexual drives.
The ego develops to negotiate with the objective, external reality. It is subject to the principle of reality and has to do with psychical functions such as memory, attention and perception. According to Freud, one can memorize thanks to the ego. On the other hand, the ego has as many conscious aspects - such as notions we know or believe of ourselves and we can express through concepts (e.g. I have this characteristics) - as unconscious aspects, such as the unconscious feeling of guilt. It is the executive mediator between the id and the superego. They operate unconsciously, regardless of the individual conscience, and they either deny, forge or distort reality, thus becoming the rumor generators.
Finally, the superego is created by internalizing parental demands and prohibitions. It tells us, automatically and unconsciously, what we can or cannot do, what is right and what is wrong. One instance of the superego is the so-called moral conscience, represented by this formula: this is the way you should be. It is just the accumulation of norms and notions

[20] Everett M. Rogers, *A History of Communication Study* (New York, The Free Press, a division of Simon & Schuster Inc, 1994), page 70

[21] Sigmund Freud, *Formulierungen über die zwei Prinzipien des Psychischen Geschehens*. (Psychoanalytische Psychopathologische Forschungen, Wien, 1911) Volume 3, pages 1-8.

of what is good and bad transmitted by parents acting as transmitters of cultural standards and values.

We said that the ego is the executive mediator between the id and the superego. When rational methods fail, the ego may be forced to resort to radical and unreal measures to release extreme pressure. In this case, it operates unconsciously by denying, forging or distorting reality. This is the defense mechanism through which the ego releases tension in an ambiguous or uncertain situation. When facing a tense or critical situation, if information is insufficient, unsatisfactory or ambiguous for the individual, his fantasy may unconsciously re-create, according to the Freudian psychoanalytical theory, a deterministic reality to which he attributes a high level of probability: at that moment, the rumor is shaped and becomes alive. The constant absence of the expected satisfaction, the disappointment is replaced by satisfaction through hallucination[22].
According to Freud, the rumor is the *unclear massive not expressed communication focused on the information of an event that will occur and that has an expressed content and a latent one, and can be operationally interpreted as a dream[23].*
Given its condition of situational and operational emergent, no rumor is innocent. According to Freud's description, the first process, which rules the creation of rumors is a mechanism, called “rationalization”, which permanently acts in our psychic life. He points out that we witness a double process where the individual breaks down the information in order to deny the dangers locked in the rumor. The reasoned sentences serve as instruments, but the individual cannot avoid re-building the information according to his personal style, weaving in his fantasies and concealing his wishes by following the dynamics of dream building step by step[24].

1.1.1.3 Jung's Perspective

Jung's psychoanalytical theory of the rumor[25] follows Freud's rationale in the sense that since individuals transmit and respond to rumor, it should somehow satisfy individual needs. As rumor is frequent, it is understood that needs are widely spread. Similar rumors appear in different cultures and at different times; this implies that there must be universal needs. According to Jung[26], for the diffusion of an “ordinary” rumor, “popular curiosity and traffic of sensations” are enough. Rumors express anxieties and hostilities. (We know that rumors can be catalysts, or the source of fears and apprehension).
In psychoanalytic terms, the passing of rumors is a defense mechanism. It relieves the self by setting free the uncomfortable pressures of over-anxiety. This is achieved thanks to the

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[22] Sigmund Freud, *Formulierungen über die zwei Prinzipien des Psychischen Geschehens*. (Gesammelte Werke, Wien, 1911) volume 8, page230-238.

[23] Enrique Pichón-Rivière and Ana Pampliega de Quiroga, *Psicología de la Vida Cotidiana*, (Buenos Aires, Ediciones Nueva Visión, 1985), page 47

[24] Enrique Pichón-Rivière and Ana Pampliega de Quiroga, *op. cit.*, page 51-52

[25] Carl G. Jung, *Analytical Psychology*. (New York, Moffat Yard & Co., 1916)

[26] Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976), page 52

process of projection: anxieties become minor threats if we project unacceptable desires or feelings, which in fact are our own, to external factors[27].

To illustrate this principle, Jung analyzed a rumor at a girls' school based on a semi-erotic dream of one of the girls. The dream and the rumor expressed the ambivalent love-hatred relationship between a student and her male teacher. Quoting Jung *"... the dream created the first expression that there was something in the air; it was the spark that fell on the gunpowder pile.[28]"*

Jung's theory on ordinary rumors was stated in terms of individual needs and self-defensive reactions. Jung also analyses a variation of everyday rumor, characterized by an expression in the shape of a vision, which explains the term "visionary rumor". In this case, collective needs are emphasized instead of individual ones. The primary requirement of a visionary rumor is an unusual emotion with a stronger level of excitement than ordinary rumors. From Jung's perspective, those emotions reside in ancient ideas (archetypes), inherent to the collective unconscious, the cultural inheritance of the personality. Therefore, the primitive archetype of innocent death, an idea transmitted in the culture from generation to generation, is a recurrent topic in folklore and legends[29].

Rumors on UFOs are also regarded as projections of archetypal images. It is thought that their emotional base is anguish originated in collective fear and anxiety about the situation in the world and the universal wish for a redeeming supernatural force. Therefore, the rumor of the UFO is a recurrent topic: in the 16th century there were records of "balloons" and "tubes" rapidly moving in the air and sometimes colliding as if they were in a battle.

"The only way to measure the functional meaning of rumor in social life is by examining the deep layers of personality and the economy of the mental life of individuals"[30]. According to analytical psychology and the author of Collective Unconscious, there is no place for individuals' needs, impulses and actions as long as they are involved in group behavior. However, Jung acknowledges that *"certain crowds are sensitive to peculiar rumors. These rumor transmission chains depend on the level of suggestion of the individuals who compose them. The more intense the excitement, the more numerous the chain"[31].*

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[27] Allport and Postman agree on the fact that "rumors usually represent an immediate discharge for emotional tension since they provide a verbal outlet that brings about relief; they often protect and account for the existence of states of mind, which if openly faced could be unacceptable for the carrier; they sometimes help provide a broader interpretation of intricated aspects of the surrounding world, and therefore they play a major role in the intellectual effort aimed at turning the environment we live in into an intelligible whole. This triple dynamics is seldom, if so, understood by the rumor transmitter. He does not know why there is a certain buzz in the air that seems to deeply interest him and deserves an urgent and wide diffusion. He does not even notice the scope of the echo that reflects him in the spreading voices, since he does not comprehend the mechanism of the 'projection phenomenon'" . G.W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947), page 19

[28] Carl G. Jung, "A Contribution to the Psychology of Rumor", *Collected Papers on Analytic Psychology* (London, Barlliere, Tindal & Cox, 1922), pages 188-189; cited by Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay*, page 53; also cited by Terry Ann Knopf, *Rumors, Race and Riots*, page 73

[29] Carl G. Jung, "A Visionary Rumor", *Journal of Analytical Psychology 4*. (1959), pages 5-19; cited by Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay*, page 57

[30] Carl G. Jung, *Analytical Psychology*. (New York, Moffat Yard & Co., 1916)

[31] Ibid.

1.1.1.4 Rumor and Festinger´s Cognitive Dissonance

Leon Festinger's well-known theory of dissonance[32] also speculates on the self-defensive function of rumor. The theory states that there will exist dissonance between two ideas (or cognitions) when the opposite of one follows the other. For example, two dissonant cognitions could be:

(a) I detest rumormongers,
(b) I like to hear a juicy rumor.

The dissonance of these discrepant ideas works as any other impulse. If we are hungry, we do something to reduce our discomfort; if we experience cognitive dissonance, we do something to reduce our discomfort in that respect.
The inspiration of the theory of cognitive dissonance was found in Festinger's efforts to reconcile an intriguing discrepancy in the behavior of the inhabitants in India after an important earthquake. Unlike the hedonist assumption that people will discharge unpleasant things from the mind, there was a continuous flow of rumors which predicted calamities; and these exaggerated expectations of destruction and disaster prevailed in the regions least affected by the earthquake. Festinger explained that rumors were the efforts to appease the mind, but since people lacked a concrete base for their fears, they created reasons to reduce the psychological discomfort, which originated two opposing ideas (i.e. they had no injuries, but they still felt anxiety, apprehension).

1.1.1.5 Social Psychological Perspective

Unlike Allport and Postman's Gestaltic vision, social psychology follows Freud in stating that *the rumor is the unclear massive not expressed communication focused on the information of an event which will occur*[33]*.* For this school of thought, aligned with psychoanalysis, rumor is a subliminal message susceptible to feedback and exchange, with two contents -one of them manifest and another latent- that can be operationally interpreted as a dream.
The starting point of chain transmission featured by the rumor, according to Pichón-Rivière[34], is a real but distorted event. They are tension situations, expectations always determined by socio-economic factors, which lead to the modification of the perception of an event and its deformation.

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[32] Leon Festinger, *A Theory of Cognitive Dissonance*. (California, Standford University Press. 1957).
See also: Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976), page 53-54

[33] Enrique Pichón-Rivière and Ana Pampliega de Quiroga, *Psicología de la Vida Cotidiana* (Buenos Aires, Ediciones Nueva Visión, 1985), page 47

[34] Enrique Pichón-Rivière and Ana Pampliega de Quiroga, *op. cit.*, page 47

According to the author of *Psychology of Everyday Life*, social situations operate like substratum for the crisis situation, characterized by a state of “anomie” or social disintegration. Within this framework, the underlying violence resulting from accumulation of frustrations prepares the setting from which, based on a real fact but misplaced and distorted, the transmitter-recipient pair emerges[35].

As long as it is interpreted as a significant emergent, the rumor loses its condition of unreality. In this sense, it is *a false definition of a situation that originates a new behavior that tends to turn a concept that is originally false into a true one*. It is like a wrong prophecy, which succeeds in becoming true in virtue of its own discourse[36].
According to social psychology, no rumor is innocent since it always carries intention and sense due to its condition of situational and operational emergent. There is coincidence with experimental psychology in this point.

To sum up: in the construction of the rumor there is a mechanism described by Freud as *rationalization*, which permanently acts in our psychic life. As we said before, we witness a double process where the individual breaks down the information, i.e. disassembles it, in order to deny the dangers locked in the rumor. The reasoned sentences serve as an instruments, but the individual cannot avoid re-building the information according to his personal style, weaving in his fantasies and concealing his wishes by following the dynamics of dream building step by step. From the social point of view, this apparently naive denial mechanism can absorb other ingredients, and elements like fraud, complicity and betrayal come into play.
This rationalization device which gives us excuses turned into reasons follows the same distortion -with more or less intensity - as the one suffered by most communication means among individuals[37].

In his article *A Psychology of Rumor*[38], published in the third quarter of 1944 in Public Opinion Quarterly, Robert Knapp highlights the importance of individual anxiety on rumors at times of war. He refers to the situation in England at the time of the First World War, when the morale was extremely low. According to Knapp, in that extremely critical period, Great Britain was filled with rumors about the disembarkation of large numbers of Russian troops in the battlefield. These rumors, naturally false, kept on circulating despite the repetition of contrary official communications. Knapp explains the tenacity of rumors with the hypothesis that rumors contributed to establish a feeling of insecurity in the frightened and insecure population.

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[35] “Diffusion – states Pichón-Rivière- finds free communication paths because fear and expectations lead us to absorb the rumor, which starts to multiply itself, covering an area with an intensity that get higher as uncertainty and insecurity grow around the basic issue: the need. Individuals tend to revise their ideologies and assume a critical attitude; through diffusion of the rumor he starts to feel he can get a certain security, because he is part of the action now” (Enrique Pichón-Rivière and Ana Pampliega de Quiroga, *Psicología de la Vida Cotidiana* (Buenos Aires, Ediciones Nueva Visión, 1985), page 48

[36] Enrique Pichón-Rivière and Ana Pampliega de Quiroga, *op. cit.*, page 50

[37] Enrique Pichón-Rivière and Ana Pampliega de Quiroga, *op. cit.*, page 52

[38] Robert H. Knapp, “Psychology of Rumor”, *Public Opinion Quarterly* (vol. 8 Nº1, 1944) page 31- 33; cited by Terry Ann Knopf, *Rumors, Race and Riots*, page 72

A similar explanation applies in the case of the numerous rumors about the disappearance of Hitler, Mussolini, Tojo and other dictators during Second World War. *"The hostile and aggressive quality of rumors was to make the individual safer, to protect him from his anxiety"*[39].

Allport and Postman also defined rumor as a specific proposal to be believed, whose origin lies in the needs, impulses and interests of the individual. They consider that formation and spreading of rumors is the outcome of emotions (defense mechanism) against feelings which, if directly faced, can turn out to be unacceptable for the individual or else difficult to handle. According to this interpretation, rumors can alleviate feelings of guilt, anxiety, fear, wrath, resentment or hostility[40].

It is not surprising that the psychological model of rumor finds an extremely important factor for rumor-generation in the individual's personality traits. According to this trend, it is possible for many rumors to have a neurotic foundation. Among the most common rumors quoted, we can find those whose purpose is to strengthen a weak self-image. Here we see the need of some people to be the center of attention, to reach an outstanding position among their peers through the possession of "the latest information or news", and the speaker tends to relate the rumor to himself[41].

In a paper published in the American Journal of Sociology in 1940[42], Peterson and Gist express that disclosing "inside information" about a topic of public interest, places the individual who spreads it in a transitory prestigious situation. The more credible the story, the more prestige for the individual who spreads it. It is almost a logical consequence that the rumor transmitter often "forgets" certain details that can turn the version doubtful, while he consolidates those that grant credibility and plausibility to the rumor.

Some researchers, Knopf states[43], have claimed that the rumor is a pathological phenomenon, rather than something that can be expected from an ordinary person under certain circumstances. In that case, it is possible to think that rumors are initiated by individuals suffering from some type of emotional disorder. Within this classification we can find rumors based on hallucinations or mythomania.

Allport and Postman[44] do not go as far as to state that the cause of rumor lies in pathological attitudes or some type of mental insanity. From their perspective, it is absolutely ordinary individuals who, under certain circumstances or pressure, tend to make up stories.

Despite the emphasis of the psychological viewpoint on individual personality traits and emotions regarding the rumor-formation process, the set of social factors cannot be left

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39 Ibid. , page 32

40 Terry Ann Knopf, *Rumors, Race and Riots* (New Jersey, Transaction Books, 1975), page 71

41 Bernard Hart, *Psychopathology: Its Development and its Place in Medicine* (Cambridge, England, Cambridge University Press, 1939) page 121; cited by Terry Ann Knopf, *Rumors, Race and Riots*, page 73

42 W.A. Peterson and N.P Gist, "Rumor and Public Opinion" , *American Journal of Sociology* (vol. 57 Nº 2, 1951), page 166; cited by Terry Ann Knopf, *Rumors, Race and Riots,* page 73

43 Terry Ann Knopf, *Rumors, Race and Riots* (New Jersey, Transaction Books, 1975), page 74

44 Gordon W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947), page 196; cited by Terry Ann Knopf, *Rumors, Race and Riots,* page 75

aside. Some researchers even visualize in the rumor both a psychological and a social problem. These researchers highlight the prevalence of rumor in critical situations such as panic, epidemics, wars, social turmoil and natural disasters. *"The spread of rumors is always a social and psychological problem of magnitude, specially at critical times. Whenever there is tension in the social environment, the spreading of false news turns really virulent "*[45].

Anyway, the introduction of the social factor shows certain deficiencies in the psychological model of the rumor since, although it explains the role of rumor in social situations, it fails to consider the social situation itself, such as the environment, the framework or circumstances, where the rumor is created. The psychological model only considers the nature of the individual as the rumor-generating factor.

In 1939, Robert Hart[46] admitted the inadequacy of analyzing rumors as a mere link in the spreading of information among individuals. However, in his attempt to reconcile the social factors with the psychological ones, Hart only showed his contradictions.

On the one hand, he defines rumor as *"a complex phenomenon that mainly consists of the transmission of information (report) through a succession of individuals";* on the other hand, he adds that it is "*something that occurs in communities and has certain properties specifically attributable to this fact*". He finally closes the circle by stating that *"crowds undoubtedly constitute the fertilizer where rumors grow and prosper"*. His attempt to clarify individual versus group factors only shed more shadows on the matter.

According to Knopf[47], inconsistency of the psychological model of rumor has to do with a far from plausible premise, which de-articulates the model itself: from the psychological perspective, rumors are considered phenomena whose base is emotional, often neurotic and sometimes even pathological. Taking this premise as an assumption, individuals with stable and rational features are ruled out as rumor initiators and transmitters. However, this would contradict an obvious fact of life: that all of us think and act daily on the basis of unproven information. In addition, the psychological theory supports the today dated perspective that social uproars (Knopf's field) have an irrational, insensitive and senseless origin, and whose participants are more prone to rumor because they are more neurotic. This is not the case according to the research conducted by Knopf when she was research associate at the U.S. Lemberg Violence Center, in Brandeis University. She determined that rumor is essentially a social phenomenon. It is not that during an uproar a great number of people simply take time to build and spread rumors. According to the author, the rumors reflect topics and concerns of the community, such as civil or police brutality, rapes or conspiracy, which go beyond the daily individual concern. "There is no way for the psychological perspective to either support or explain this discovery", says the researcher[48].

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[45] Gordon W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947), page 9

[46] Bernard Hart, *Psychopathology: Its Development and its Place in Medicine* (Cambridge, England, Cambridge University Press, 1939) pages 94, 112and 114; cited by Terry Ann Knopf, *Rumors, Race and Riots*, page 76

[47] Terry Ann Knopf, *Rumors, Race and Riots* (New Jersey, Transaction Books, 1975), page 77

[48] Ibid. , pages 77-78

1.1.2 The Sociological Model

In the sociological model, the starting point is the rumor as a social function. This model was first methodologically outlined by Tamotstu Shibutani[49] in 1966.
Shibutani, a philosophy graduate from the Chicago University (1948) and professor at the University of California, Santa Barbara, U.S. claims that the rumor analysis involves the social factor from two perspectives. He defines rumor as *"a collective transaction whose components have cognitive and communicative activity; this transaction develops as individuals, involved in an ambiguous situation, attempt to build a meaningful interpretation of it by joining their intellectual resources".*

According to Shibutani[50], rumors are considered a collective undertaking because they are not the simple creation of an individual. Shibutani refers to collective transaction where rumors are crystallized and grow with the aid of several interdependent people[51].
Participants do not parrot what they have heard. They have gotten together to speak about topics of interest and they share a common concern. There is a give and take, ideas are shunted back and forth and there is an exchange of different points of view.
For Shibutani, there is a division of labor so that different participants make different contributions. Some risk opinions about what might happen; others predict what will happen; some compare previous situations and others introduce new information. Opinions are weighed and statements, explanations and thoughts are ventured. All members of the group will make their own contribution to create, re-create and reinforce the rumor.
This mutual exchange of ideas, reflections, feelings and wishes results in certain information aspects that stand out from the rest. It is in this way and as a result of collective interpretation that rumors are born and developed.

The second perspective focuses on the conditions and circumstances in which the rumor is produced and spread. Rumors are generated in the immediate situation that causes the group's gathering. It is generally an irregular, unexpected and unfamiliar event. This event, according to Shibutani, can have a great dramatic component, e.g. a murder, a kidnapping, a flood, an epidemic, or a street riot. But the event can be much less dramatic and simply out of the ordinary, such as a car accident, a job resignation, a traffic siren or a

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[49] Tamotsu Shibutani, *Improvised News, A Sociological Study of Rumor* (Indianapolis- New York, The Bobbs-Merrill Co Inc, 1966), pages 9- 29

[50] Shibutani conceives rumor as "as a collective enterprise that gets its organization and direction in the collaboration of a multitude of persons. To be sure, only individuals and their acts are involved, but the individuals are acting not as independent entities but as participants in larger transactions. They do not deny that rumors are sometimes inaccurate, but they have focused their attention on problems other than falsehood." Tamotsu Shibutani, *Improvised News. A Sociological Study of Rumor*. (The Bobbs-Merrill Company, Inc., Indianapolis, 1966). Page 9

[51] Knopf contradicts this collective action theory, stating that rumor mongering is an independent action: "Shibutani speaks of a "collective transaction", in which rumors arise and takes shape from the collaboration of many persons. Of course, individuals are involved; but they are interdependent. The participants do not simply parrot what they have heard. Instead, people are brought together to discuss matters of concern-matters of common preoccupation." Terry Ann Knopf, *Rumors, Race and Riots*. (New Jersey, Transaction Books, 1975). Page 80

police arrest. Each incident affects the daily routine and will be culture broth for rumor. However, it is important that ambiguity surrounds the event in question for the rumor to occur. It should not be immediately clear what has happened or is happening when people are getting acquainted on the matter, and try to understand the event in order to solve the situation and take decisions.
The problematic nature of the situation is the epicenter of the functional anchor for the rumor. In such a situation, information is urgently required. This information needs to be helpful to understand the event and at the same time it has to be adjustable, as a piece in a puzzle, to the uncertain situation. Within this framework, the public becomes highly receptive for any kind of news. This demand for information and news is in direct proportion to the importance given by the individual to the event or incident. The more important the event is to him, the stronger the demand for information. Important news affects an important number of people.

For a better understanding of the functionalist model of communication, we should focus on Charles Wright´s first works.
In his essay *Functional Analysis and Mass Communication*, introduced in Milan in 1959 for the IV Worldwide Congress on Sociology[52], Wright describes a conceptual structure which makes it possible to get an inventory of the complex relations between mass media and society, in functional terms. His work aimed at the articulation of functions and dysfunctions, both latent and manifest of journalistic, informational, cultural and entertainment transmissions in connection with society, groups, individuals and the cultural system.
Regarding society, Wright considers that the spread of information through the mass media has two functions: on the one hand, it provides the instruments to perform some everyday activities institutionalized in society, i.e. economic exchanges, etc.; on the other, it gives citizens a possibility of alert in case of unexpected threats and dangers (Wright, 1974). When this second function fails, Knopf assures that rumors appear.
The individuals who are immersed in situations they do not properly understand tend to resort to mass media -especially radio, TV and newspapers- in order to clarify and verify what they have heard. Therefore, the news supplied by the media becomes the standard, the pattern by which the information obtained elsewhere is either validated or replaced[53].
The system is based on the supply and demand and works to the extent that the information supply meets and satisfies the public's demand. An event can be so sensational that the most extreme efforts of the media may appear as insufficient to cover information over-demand. Or perhaps the media, for whatever reason fail to transmit any information, as is the case of censorship in times of war or journalists strikes. These two examples are completely different, but the effect is the same: the sudden interruption of the information flow. Another example could be a general black out: under these circumstances the media cannot operate.
In other words, there can be occasions in which the system fails to work, when regular communications do not work properly or are interrupted. Under these conditions, when the expected news fails to reach the public, collective tension grows.

[52] Charles R. Wright, "Functional Analysis and Mass Communication", *Public Opinion Quarterly* (Nº 24, 1960).

[53] Terry Ann Knopf, *Rumors, Race and Riots*. (New Jersey, Transaction Books, 1975). Page 82

It is here when the functional aspect of rumors becomes apparent, because they play the role of a sort of *improvised news*[54]. They explain what is not clear, provide details by responding questions, help take decisions and, above all, soothe the collective tension. According to Shibutani, the creation of rumors represents a kind of collective solution to problems.

The death of the Princess of Wales, discussed in the following chapter, explains Shibutani's model[55]. To begin with, this episode contains two important elements of his model. First, the event was highly unusual (it is not every day that a celebrity such as “Lady Di”, the most photographed woman by all the media worldwide dies). Then, the event in question was *important* in itself for the public, since it involved a character not only related to the British Royal Family (the Crown heir's mother) but someone who had strong differences with the Queen of England herself.
Second, the thousands of curious people at the place of the event and the tons of flowers at the door of Buckingham Palace after some days, showed the great interest of the public on the matter; this is supported by the thousands of reporters who covered the incident. The *demand for information* was high at all times, as well as the level of *ambiguity* surrounding the event -third and essential ingredient of Shibutani´s model.

1.1.2.1 The Rumor as Function of Disinformation

Guy Durandin, social psychologist from René-Descartes University, Paris, in his paper on disinformation, analyses rumors as the object of manipulation of public opinion. *“When there is not enough time to verify information at times of crisis, news passes on, regardless of whether it is true or false, and ignoring where or who it comes from”*[56]*.*

According to Durandin[57], rumor has three purposes in connection with disinformation:
1. slander
2. discredit for the adversary's information system, and
3. the spreading of contradictory news

The first case is illustrated with an example from 1973. An MI5 agent (British espionage service), in charge of the press department of the British Army in Northern Ireland, was appointed to distribute slander information about different personalities of Catholic Ireland. Among other actions, he succeeded in convincing a U.S. reporter that the Northern Ireland

[54] Ibid.

[55] We could summarize that model in the following paragraph: “Rumor is a substitute for news; in fact, it consists of a piece of news which is not developed through the institutionalized channels. An unsatisfied demand for news - i.e. a discrepancy between the information needed in order to deal with a changing environment and the information provided by the formal channels – constitutes the main condition for rumor building. News demand may arise as the result of the effort to overcome an unexpected event or a framework of sustained collective tension...” Tamotsu Shibutani, *Improvised News. A Sociological Study of Rumor*. (The Bobbs-Merrill Company, Inc., Indianapolis, 1966). Page 62

[56] Guy Durandin, *La Información, la Desinformación y la Realidad* (Barcelona, Ediciones Piados Ibérica, 1995), page 193.

[57] Guy Durandin, *op. cit.*, page 198

State Secretary was in favor of the IRA. This untrue information was published in the United States in a second line Mid West newspaper; and as a result, Americans of Irish origin in favor of the Republican cause, wrote to the Secretary to congratulate him.
These letters, authentic in themselves, were intercepted by the British Secret Services which spread them as if they were information leaks (Le Monde, 11.15.1990).

If they wish to succeed such operations should be constituted by a five-step process, according to Durandin[58]:

1. The false news or the rumor is launched to a small group.
2. It is captured by one or several media representatives and is transmitted to a wider audience.
3. The news causes an impact on a certain number of individuals within that group.
4. The existence of these reactions is spread.
5. Reactions are used as evidence in connection with the initial accusation (since IRA fans thank him for what he does, the secretary is in favor of IRA).

Regarding the second type of rumor, i.e. discrediting the information system of the adversary, false news is issued and is claimed to belong to the opposing source. The news is later proven invalid by facts themselves or simply because of its false origin. It is then easy to denounce the “lies” of the adversary and discredit the set of issued information. Goebbel used to boast of his excelling use of this technique.

In the third case, i.e. disseminating contradictory news, what is being sought is to confuse people in order to dishearten them. For example, in the campaign against Poland in 1939, Germans disseminated contradictory news, including alleged Polish victories. When hope and deception mix in this way, it is neither possible to know who to believe in, nor what to decide. The situation gets out of control. This procedure is also based on the principle of the unknown source: since the rumors come from everybody and nobody, contradictions are launched without difficulty. We do not know who to believe in, and there is nobody to be taken seriously[59].

The phenomenon of rumor, according to Durandin, is an easy vehicle for the de-informer: given the fact that the source of rumors is seldom the subject of methodic research by people who hear and repeat them, the de-informer can divulge false news without any responsibility on his part.

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[58] Guy Durandin, *op. cit.,* page 198

[59] Vogel gives the example of the use of rumors by the Secret Service in the former Democratic Republic of Germany (DDR): “May be the most notorious example of rumor utilization by the State is represented by the disinformation policy of the DDR Intelligence Agency described by Bernd Eisenfeld from his viewpoint as a member of the Gauck (organism created by Germany after the fall of the Wall for the analysis and solution of all the cases in connection with oppression and internal espionage in the former DDR). The rumors generated by the Stasi (Secret Service in the former DDR) and their collaborator constitute an important sample in the catalog of tools to suppress any type of political opposition to the DDR, both internally and externally”. Jakob Vogel, “Politics of Rumor. Social Communication and Totalitarism Practices in the early Modern Age and Contemporary Times”. *History Workshop 15: Politics of Rumor*, (Hamburg, Ergebnisse Verlag GmbH, 1996. Page 7). Original in German. See Bibliography

1.1.3 Koenig, Kapfererer and Rowan´s Typologies

Rumors can serve, as any kind of disinformation, different purposes. Four decades ago, Daugherty and Janowitz attempted to make a list of topics, which proved to be vague and not credible; therefore, it is not worth reproducing[60].

Frederik Koenig[61] divides rumors into two categories: conspiracy rumors and contaminating rumors. The former are generally related to political, religious or ideological movements; the latter have a commercial purpose.

Jean-Noël Kapferer, professor of Economics at the University of Paris, has studied the phenomenon of rumor for over 20 years. His work *Rumeurs. Le Plus Vieux Média du Monde*[62], first published in 1987, is a classic and compulsory reading material for those interested in the phenomenon.

Kapferer claims that rumors respond to an irrefutable logic whose mechanisms can be analyzed separately. His research is based on the same starting point as his antecessors; however, unlike them, he does not focus on war rumors (Allport and Postman), nor social uproar (Knopf). His work focuses primarily on the analysis of corporate rumors. In his opinion, an essential task of all science is the classification of the subject matter, and the theory of rumor should not be an exception. He therefore refers to the classification attempts of rumor contents made by G. Benett and Koenig. Kapferer refutes this method since, in his opinion, the typologies referring to content are linked to the symbolic language; therefore, the object gets the leading role in the analysis. This invalidates the research since the same object can have different symbolic content depending on the culture, the times and the environment where the rumor has appeared. *"If we assume wrong meaning, the wrong function may be taken"*[63], says Kapferer, who classified rumors into six different types, according to their genesis and source/origin[64]:

[60] W.E. Daugherty and M. Janowitz, *A Psychological Warfare Casebook* (Baltimore, The John Hopkins Press, 1958) Pages 657-666

[61] Fredrick Koenig, *Rumor in the Marketplace: The Social Psychology of Commercial Hearsay* (London, Auburn House Publishing Company, 1985), page 39

[62] Jean Noël Kapferer, *Rumores: el Medio de Difusión más Antiguo del Mundo* (Barcelona, Plaza y Janes Editores, 1989)

[63] In the German edition by Gustave Kiepenheuer Verlag, 1995 of the work "Gerüchte. Das Älteste Massenmedium der Welt", page 323, Jean-Noël Kapferer adds an epilog to this typification which is not included neither in the Spanish version published by Plaza y Janes Editores, Barcelona, 1989, nor in the English version published by Transaction Publishers, London, 1990. In that epilog, Kapferer refers to the latest status in his investigations and states that "since the first edition of the present book, research and theories about rumor have continued their development. Several exemplary cases of rumors have been the subject of observation and analysis and new trends of thought and models have crystallized around them. In consequence it has become necessary to summarize the most recent and newest developments. (…). Despite the fact that we usually talk about "the rumor", the actual truth is that there are rumors that differ according to their content, function, or origin".

[64] Jean Noël Kapferer, *Rumors: Uses, Interpretations & Images* (New Brunswick and London, Transaction Publishers, 1990), page 37

Source/origin Genesis	Based on a fact	Based on a detail	Pure fantasy
Spontaneous Generation	1	3	5
Driven Generation	2	4	6

The first type, according to the chart, refers to rumors that originate in a fact concerning the public opinion. The example is something that took place in Mourmelon, France, where eight soldiers mysteriously disappeared near an operations field in 1980. The public dismay derived from this episode increased as time went by due to the negative outcome of the Police investigation. Eight years after, there was still no sign of the soldiers.
Over time, two rumors were generated. According to the first one, a German truck driver was responsible for the crime, whereas the second rumor related it to crazed homosexual former member of the Legion.
Since the public lacked rapid and clarifying answers, they created a personal and collective perspective of the fact. According to Kapferer's analysis, this process is spontaneous and natural: the group generates and chooses the most convincing hypothesis and the one considered most likely to be true by the group.
Of course, certain hypotheses are voluntarily formulated by certain members of the group who wish to take advantage of the situation; this cannot be disregarded. This is the case of rumor type Nº2. Here is an example of this type: When Pope John Paul I suddenly died, shortly after being crowned on September 28, 1978, public excitement spread all over the Christian world. The rumor that he had been murdered (as a result of a conspiracy) was rapidly passed on. After a short period, a book based on this thesis claimed that the Pope had not died of natural causes but victim of a complot.

The third type is not based on a fact but on a detail, a sign that had not caught attention at the beginning or something that had not received enough attention.
If a group is to perceive a sign, the group has to dedicate a minimum of attention, which will show that the group is sensibilized and alert to the minimum detail that can be extracted or taken as evidence. Fundamentalist communities from the South of the United States are so convinced of Satan's existence on the earth that they make efforts to find evidence anywhere. This is the reason that drove them to show that the Procter & Gamble´s logo bears the number 6 three times, which is the symbol of Beelzebub. P&G's case is a paradigm and will be discussed in the following chapter.
In this case, it is also possible that someone, e.g. a competitor, intentionally passed on the rumor in order to damage his rival. If that is the case, this rumor is type Nº4.
The characteristic of type Nº 5 rumors is that they have no definite origin. Kapferer's research does not show any fact, symptom, sign or detail from which any interpretation could be inferred. This type of rumor, therefore, is pure fantasy. The example of the kid apparently bitten by a snake hidden among the bananas in a supermarket -a popular rumor in U.S. in the 70´s- illustrates this typology. These rumors, true “collective dreams” which appear in society and are re-generated and massively spread from time to time, are also called urban legends[65].

[65] G Bennet, *Perspectives on Contemporary Legend*. (Sheffield, Academic Press, 1987).

1.1.3.1 Urban Legends

The urban legend is a story passed on from person to person through informal channels of communication. As we will see later, these channels can be mouth-to-mouth, photocopies, a fax from a friend, an e-mail or a newsgroup on the Internet. Its content is believable, whether based on a real fact or not.

In order to highlight the characteristic of this type of rumor, the same story is reproduced as press information (A) and as an urban legend (B):

A. *"José Perez, 29, died yesterday at the Rivadavia Hospital from the injuries caused as a consequence of jumping from his apartment located on Billinghurst St., on the 10th floor. The coroner in charge of the autopsy reported to this newspaper that residues of the hallucinogen drug LSD were found in the body of the deceased. The police informed that several illegal drugs were found in the young man's apartment. According to the victim's brother, his last words were "Now I can fly"".*
B. *"I heard that some guy who had a lot of LSD jumped out of his window and died because he believed he had learnt to fly".*

An urban legend can be generated when someone, after reading a story, re-creates it and passes it on to someone else; or when a joke is told and then re-transmitted as a true story, whether by mistake or because it sounds funnier. On the other hand, a real story can result in a joke (who knows? Did the story of the one who tried to dry his cat in the microwave start as a joke or as an urban legend?)

The case of the sale of those "ink stickers" with tattoos for kids which were said to contain LSD is a case of a recurrent urban legend. There may have been a real case behind this, or perhaps it was the invention of a joker. We will never know.

According to David Emery, who keeps a page on the Internet called " Urban Legends and Folklore" (http://urbanlegends.about.com), urban legends are allegedly true popular narratives which are transmitted from person to person through word of mouth or written communication means (including e-mail or fax). They narrate stories involving certain combinations of strange, humiliating, humorous, terrifying or supernatural events, which in all cases have happened to someone else. In order to gain credibility, the transmitter of an urban legend relies on a good narrative, citing a reliable source (in most cases "the friend of a friend"), more than on verifiable data. Often, although not in all cases, there is an underlying moral to the story, such as "be careful or something wrong can happen to you".

Urban legends constitute a type of folklore (traditions, stories and beliefs of the peoples) of ordinary people.

According to Emery, since urban legends are a type of rumor, they are difficult to trace as originating in a single source (e.g. a newspaper article or a TV program) and they seem to come from nowhere. Since their diffusion is oral and not through the media, there are never two versions of a legend that are exactly the same. There are as many variants as transmitters spread them.[66]

[66] In a note published in the newsgroup "alt.folklore.urban" Ian A. York (http://www.urbanlegends.com/misc/uls_and_memory.html) claims that talking about "lies" when people transmit an urban legend type rumor is inappropriate. From his point of view, the narrative deformation only illustrates how defective the process of human memory is. Memories are stored as semi-independent bit packages the same way as digitized data packages are transmitted over the Internet. Since these "packages" are also linked to other ideas in our brain (the well know "free association"), when the memories are brought

A famous urban legend is the following: On 14 July, 1977, at 9:35 p.m., the lights in New Your City surprisingly went off, and came back on after 25 hours. Similar situations had been reported before that day, but no black out had lasted as long as that one before. The power companies managers only explained that it was due to a “chain effect”: people had been using their air-conditioning sets without interruption due to the heat. This added to an overload of power connections and the fact that lightning bolt had struck one of the main transformers of the city. All the lights suddenly went off. Thousands of passengers were trapped in the subway and elevators in the skyscrapers of the city. As traffic lights did not work, the traffic on the streets turned into a chaos and a feeling of panic filled the Big Apple. It is estimated that the black out affected over 10 million people. All types of rumors rapidly began to circulate in this collective panic-filled critical situation. To make matters worse, it was impossible for the media to broadcast information on the causes of the black out. Abraham Beane, the Mayor of the City, declared an emergency and asked the citizens who possessed battery radios -through radio stations outside the black out area- not to use the telephone lines. Some people took advantage of the black out. According to the records, 1,328 stores were robbed that night. As alarms were out of order, thieves took advantage of the situation.
After some time, the media published versions suggesting that the black out had had other consequences. According to the reports, nine months after that July 14, it was said that births had tripled in the city. Although statistics tried to counterbalance such a rumor with concrete figures which are not as high as the ones reported, the version kept on circulating and it is one of the most remembered incident of the blackout. It is a paradigmatic case of an urban legend.

Another example of an “urban legend” rumor type is the e-mail I received on March 18, 1999 while I was writing this book; I do not know who sent it.
It read: “Topic: READ THIS = IT´S NOT A JOKE!!!”
PLEASE BE CAREFUL!!!, Everyday I believe more that truth is stranger than fiction.”

“The following story took place one week ago at Buenos Aires News. A young man went to that disco on Saturday night to a party. He was having fun; he had a few of beers; he met a young girl, he thought she liked him and she invited him to another party. He quickly accepted and left with her.
They ended up in an apartment and kept on drinking beer.
Apparently they gave him drugs (it is unknown which ones). What he remembers is that he woke up completely naked in a bathtub full of ice. He still felt the effects of drugs and beer; he looked around and he was completely alone. He looked at his chest and found the following legend written with lipstick: “call emergency or you will die”. He saw a telephone next to the bathtub and called immediately. He explained his situation to the operator, and that he did not know where he was, what he had drunk or why he was calling. The operator advised him to walk out of the bathtub and to look at himself in the mirror. He saw

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back to the conscious mind, they might “drag along” parts of ideas that are alien to the story as originally stored. In that reconstruction process, the narrative incorporates elements from dozens of conversations, observations, myths and prejudices. Under certain circumstances, the conscious mind perceives, as it elaborates the new idea, that some elements it receives from the memory do not make sense y requests more and more additional data. Maybe, since much of the data is similar to the contents of other files in the memory, they are channeled as if they belonged to the story the subject is trying to reproduce. People’s memory, suggests York, is often weak, but very effective for reconstruction. People may be wrong in trivial points but they may also frequently fail in important points.

nothing strange, so the operator told him to look at his back. He then discovered two 9-inch slots in the lower part of his back. After telling him to go back to the bathtub, the operator said she would send an emergency ambulance.
Unluckily, after being examined at the Fernández Hospital, he realized what had happened. They had stolen his kidneys. Each of them costs U$ 30,000 in the black market (he did not know anything about this).
Some conclusions can be drawn: the second party was a sham; the people involved knew about medicine and the drugs he received were no fun. At present, this young man is at the Fernández Hospital, plugged to a system to keep him alive and waiting for a compatible kidney. Compatibility studies are being conducted in order to find a donor.
There is a new Mafia, which targets people who travel on business or academic trips. This Mafia is well organized, well financed and its members have high expertise. It can be found in numerous big cities and has recently been very active in Buenos Aires. The crime starts when someone goes to a bar or a disco. Someone approaches the target and as he is alone (preferably) or with a group of friend, the stranger starts the conversation. In the following scene, the person wakes up in a hotel room or in an apartment, in the bathtub full of ice and he only remembers the last drink. There is a note on the wall indicating him to call emergency. After calling emergency, the operator -aware of the crime- tells him to check carefully and see if he has a tube in the lower part of his back. If he finds the tube and answers yes, the operator orders him to be still and sends a doctor. Both kidneys have been taken.

This is not fake or a science-fiction story; it is real, it has been documented and confirmed.

If you go out alone or know someone who does, be extremely careful. There are experienced doctors involved in these crimes.
The Police have learnt about this and they are training their personnel.
Please, tell this story to others, share it with all the people you know.

Another recent episode took place last week in Shamrock; a man was approached by a beautiful young woman of approximately 23 years of age.
The young woman suggested leaving for his apartment, where he ended up completely drugged. When he woke up, he realized all his belongings and credit card had been robbed.
This report has been filed at the Police Department Nº 17, Barrio Norte, where you can verify it is true.

It is known that this Organized group is working in Buenos Aires News, El Codo, The Shamrock and La Mosca.
Re send this e-mail to your friends so that they are on the alert.

On the same day, I received a comment with the following text sent by one of the hundreds of addressees of the previous one. Unlike the other, I do know this person and I can attest what she says:

"These reflections are addressed to those who have received the mail about the robbery of kidneys, which I read with attention.
A month ago I received an identical one; I got in touch with the Fernández Hospital, where I was informed that:

a) *There is nobody in the Hospital with the characteristics mentioned and they are absolutely ignorant of the issue.*

b) *Someone deprived of both kidneys without any replacement for their function dies immediately.*
c) *They do not know about the existence of any emergency service or institution which instructs someone to check a tube in the lower part of their back*

I also got in touch with INCUCAI (Argentine National Central Coordinator of Ablation and Implants); the press secretary told me they knew about the existence of this rumor: They do not have an official opinion about what might be going on in the U.S.; however, in Argentina "ablation and transplant require such complex infrastructure and involve so many professionals that, in practice, its clandestine performance is impossible. It would require an illicit association of hundreds of professionals -highly specialized doctors and technicians and equipment which could only be found in a big hospital or clinic, i.e. it would require a multimillionaire investment in professionals and equipment at risk for a crime likely to be easily detected. To have an idea of the magnitude of these operations, it should be considered that a liver transplant is a 12 hour surgery and involves such complex surgical techniques that can only be performed by a reduced number of well known specialists (in the country and abroad); consequently, its illegal practice is very risky and even ridiculous.
An ablation and the subsequent transplant of organs involves the following technical equipment: the ablation equipment, the intensive care equipment which communicates the existence of a potential donor; the labs performing serology studies, histo-compatibility studies, radiology service, and transplant equipment for each organ (heart, lung, kidney, etc.) involved in ablation; all these assumes the participation of hundreds of professionals."
The massive diffusion of messages which I consider unauthentic and unproven are in detriment of INCUCAI task, an institution that is permanently dedicated to give a solution to 5,500 kidney patients -among others- whose single life saving solution is a kidney transplant.
(signed) GRACIELA

The second message proved the unauthentic nature of the first one. In addition, the use of certain terms, e.g. "bathtub", "operator", "inches" indicates that the first message is from the Hispanic community in the U.S. or a Central American country, although there is a reference to a disco and Fernández Hospital in Buenos Aires. Finally -thanks to information technology- the rumor traveled half the world, which nowadays is no miracle.
The surprising robbery of organs in infants or adults murdered or mutilated with that single commercial goal is a classic among urban legends worldwide. In fact, it is one of the most recurrent rumors. We will never know what is the intention behind their circulation or if there is any intention at all. Had there been an intention, the rumor thus created, on the basis of what is obviously a mere fantasy, would correspond to type Nº 6 in Kapferer's classification.

Roy Rowan[67] takes Kapferer´s classification partially, and makes the distinction between the origin of rumors, according to their spontaneous or premeditated origin.
Spontaneous rumors happen at times of stress and prosper in an atmosphere of anxiety, disbelief, repression and deep chaos. These rumors die when they become irrelevant. Premeditated rumors, in turn, have Machiavellian purposes, especially in highly competitive environments. It is worth mentioning that Rowan, as will be seen later, has basically analyzed the phenomenon of rumors in connection with organizations.

[67] Roy Rowan, "Where did that rumor come from?", *Fortune 100* (August 1979), pages 130-31

Rowan sub-classifies rumors into four categories: the first is called *“fulfillment of dreams*”. Dreams or fulfillment of wishes express the hope of those who make rumors circulate; according to him, they are more positive since they help stimulate others' creativity. The solution to work related problems results from the wish to change, verbally expressed by the employees of an organization. Despite its positive tone, they still represent uneasiness and sometimes anguish on the part of the employees.
The second category is the *“anxiety or ghost”* rumor. The ghost rumor derives from fears and anxiety among people, which cause uneasiness in the group, for example,, a strong budgetary cut or downsizing in a company. In this case, individuals verbally transmit their fears to the rest. This type of rumor is harmful, since they transmit anxiety and anguish to the rest of the members of the organization when they are passed on since they reflect the possibility of layoffs.
Most of the rumors, however, fall into the category of *“aggressive rumors “,* says Rowan. They are also called *wedge or motel rumors.*
The name "wedge" is used because they split groups and loyalties. The motivation is aggression or even hatred. These rumors create strong disagreements, they tend to degrade the organization or the individual and can damage the image and reputation of others. An example of a wedge rumor is when someone from X company claims that worms have been found in the hamburger manufacturing process of Y company. Or -in another context- when a schoolboy says to his friends that another boy has AIDS. A third example provided by this researcher is the story of the female employee who was supposedly caught when leaving a motel with her boss, or the one who got a promotion because she had an affair with her boss. In fact, most of these rumors belong in a category that is a by-product of the phenomenon of rumor known as *gossip*.
Rowan's fourth and last category is *“expanding rumors”*. In fact, they are anticipatory rumors, spread when the employees of a certain organization have been waiting for an announcement for a long time. It may be that just one final element is missing to complete the puzzle and this circumstance actually heightens the ambiguity of the overall situation.

1.1.4 Rumor and Gossip

Although rumor and gossip are not the same thing they are close relatives. Together with defamation and intrigue, they have existed since human beings learnt to speak. While rumor generally refers to facts, gossip refers to absent people.
Gossip is a universal way of communication; it basically differs from rumor in that it is limited to face-to-face communication or to a small group of people. Like rumor it has a functional base, but unlike rumor, gossip rarely turns out to be socially dysfunctional, since it can hardly threaten the basic structure of society itself[68].
The function of gossip is basically linked to emotions. Uncommitted idle talk helps structure interpersonal relationships and generate self-confidence. It is highly improbable for gossipy people to be aware that what they are doing is just exchanging gossip. According to Thiele-Dohrman[69], gossip is a natural component in interpersonal

[68] P. Lazarsfeld and R. Merton, *Mass Communication, Popular Taste and Organized Social Action*, cited by L Bryson, *The Communication of Ideas* (New York, Harper, 1948).

[69] Klaus Thiele-Dohrmann, *Die Scharme des Indiskreten.* (Zürich / Düsseldorf, Artemis & Winkler Verlag, 1995).

communication, and it is very strange for individuals to be aware of the fact that they are gossiping, of when they do it and what they really communicate with the gossip.
According to the social anthropologist M. Gluckman[70], gossip pertains to certain exclusive groups[71]. The more exclusive they are, the more they gossip. Continuity in the process of "badmouthing" others, i.e. gossip, updates the system of standards and values of the group and keeps them alive. This forces individuals to be involved in the gossip.

The thesis that gossip has a stabilizing function in the group has been refuted by Paine (1967) and Elías and Scotson (1965). According to Paine, it is not the society but the individual who gossip. The individual's interest in the gossip is not oriented to making the group stable; it has a personal nature. Group members participate in the gossip because, on the one hand they want to access a variety of pieces of information about certain groups of their interest; on the other hand, as data generators, they want to give their point of view about friends and acquaintances to other members of the group. They do this in order to be in control of the group and to impose their own interests.
On the basis of an empiric research, researchers have determined that the integrational function of gossip is highly relative. They state that, unlike rumor, gossip refers to "something that people simply do". As it lacks a cause, it lacks a function.
However, for Thiele-Dohrmann, the (sole) purpose of gossip is to learn about others´ secrets to benefit from and take advantage of them.
He also says that gossip broadcasters are seldom aware of the fact that they are showing part of their own weaknesses because during gossip communication, they project part of the negative characteristics of their personalities which they do not admit as their own.
There is a web of agents around gossip that society requires for control and self control. This network involves both men and women. They somehow compete with each other and compare themselves with their competitors. That is why, apart from sheer curiosity, each one tries to determine the strengths and weaknesses of their opponents. Comparison with the others and curiosity help strengthen our self-identity. The negative side of the same

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[70] M. Gluckman, "Gossip and Scandal". In: *Current Anthropology* (Nº 4, 1963).

[71] According to the research by Thiele Dohrmann, there are three types of individuals depending on their adherence to rumormongering. "The pleasure of rumor-mongering is not totally deprived of a certain degree of sickness. According to the surveys, it is possible to differentiate three groups of rumormongers. The first one and most numerous openly recognize that they like rumormongering, without attaching to it a moral statement. The recognition involved in this confession, often made in a jokingly provocative tone, is similar to a forward release, maybe founded in the conviction that it does not make much sense to conceal the fact, since sooner or later one can be caught doing it anyway or because, aware of the fact that they belong to a huge rumor-monger community, one can afford the luxury of such an open confession. Those who belong to the second group are more hesitant when answering the question about their willingness and desire to be rumormongers. They are caution in recognizing that one can never totally ignore gossip and that from time to time out of boredom they read gossipy magazines in the doctor's office waiting room or at the hairdresser's. This group manifests a moderate degree of resistance to gossip transmission, a certain degree of embarrassment for their interest in indiscreet matters and a bad feeling around the possibility of being labeled "superficial". The third and smallest group vehemently denies any desire or willingness to participate in rumormongering or they say that they have a deaf ear for gossip. In all the cases, it is obvious that there is a clear idea about the meaning of the concept of Gossip". Klaus Thiele-Dohrmann, *The Charm of the Indiscreet. A Short History of Gossip*. (Düsseldorf, Artemis & Winkler, 1995). Page11. Original in German. See note Nº 68

coin is the fact that it generates antagonism, envy, jealousy and fears, attributes which give way to malicious gossip.

A piece of gossip can originate a rumor; in turn, rumor can bring about gossiping. The credibility of both depends on the integrity of the sender. According to Kapferer, the witness who can "attest the fact" is, although not "close", generally at hand. For example, the boyfriend of a cousin who works with a government official is a "true" source[72] although he is not likely to be called to verify the information.
Anyway, for the transmission chain to work, i.e. for people to pass on gossip or rumor, they have to be ready to believe it.
According to Rosnow[73], the situation and context determine if something is rumor, information or gossip. The difference between information and rumor for Rosnow is that, in the case of rumors, the official verification is not possible. The difference between rumors and gossip is, as pointed out before, more complex. Rumor is internal news in connection with the society in general. Gossip is close and personal, while rumors are impersonal and they involve unknown people.

1.2 Rumor Channels

Talking about channels of communication implies transmission and flow of information. The illusion of defining with precision the concept of "flow of information" in a single paragraph would show a limited knowledge of the pertinent theory. However, it is important to briefly point out what is grouped under this name. Knowledge is what is known and what can be known. Knowledge, at the time of its diffusion, can be called information, which is passed from a sender to a recipient. This knowledge transfer implies a flow of information, i.e. there is an information-diffusion process. Rogers [74]defines diffusion as *the process through which innovations are spread in a social system through time.*

Information diffusion models belong to one of the theories of communication developed as from 1960; that year marks the before (dominant paradigm) and after (new theories) of a new perspective in the social communication field. There is a switch from the study of persuasive to cognitive effects, from limited to moderate effects of mass media.
These studies basically focus on the analysis of the forms of information circulation, the stages it goes through and the impact on the audience, i.e. from persuasion, information or entertainment effects to impact on the culture and opinion.
Among the diffusion models it is worth mentioning the *diffusion in multiple steps model, Rogers and Shoenmaker's diffusion of innovations model and the "J" curve model*[75] (we will come back to this point later).

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[72] Jean Noël Kapferer, *Rumores: el Medio de Difusión más Antiguo del Mundo* (Barcelona, Plaza y Janes Editores, 1989), page 71

[73] Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976), page 130

[74] Everett M. Rogers, *A History of Communication Study. A Biographical Approach*. (New York, The Free Press, 1997)

[75] Cándido Monzón, *Opinión Pública, Comunicación y Política* (Madrid, Editorial Tecnos, 1996), page 245

In all of them, diffusion can take place in various manners, but in all cases origin and destination are to be found in individuals. The study of the diffusion of knowledge, information or innovations implies the study of flows of information. That information does not flow by itself; it requires communication channels.
Stappers[76] makes a distinction between formal and informal massive communication. Formal massive communication occurs through institutionalized media, also called formal channels. Informal massive communication occurs through transmission of news outside formal channels, i.e. through informal channels, which can be better defined under the term of "interpersonal communication". Informal channels are those where mass media are not involved in diffusion of information, knowledge or innovation.
Contradicting Stappers to some extent, it is worth distinguishing the concept of *formal channel of communication* from *formal communication*, and *informal channel of communication* from *informal communication*.
A *channel* is *formal* when it is institutionalized media. In general, in this case we think of mass media: newspapers, radio stations or television channels. However, it can be fliers or official releases in an organization. In fact, the organizations' formal communication channels are very complete, including memos, reports, newsletters, e-mail, boards, etc.

Communication is *formal*, instead, when it *refers* to a formal structure, in terms of set relations required by the organization or society, within a framework of interactions given by social roles, e.g. a public speech. Its nature is specified.

A *channel* is *informal* when it does not resort to any institutionalized media, e.g. person-to-person communication or “word of mouth”.
Communication is *informal* when it is established within an informal structure, generated and maintained by individual perceptions and motivations. The informal level of communication comprises factors such as interpersonal attraction, loyalty and sense of fairness, as in a coffee talk among friends. The main distinguishing feature between interaction and formal/informal communication is that the latter depends on individual disposition and satisfaction.

People do not spread rumors without a purpose; they expect to achieve a goal. According to Shibutani[77], the reasons can be the following: the narrator wants to catch the attention of the interlocutor, has something to say, shares fears, searches for the collective solution to problems or simply tries to strengthen his self-esteem.
On the other hand, according to Allport and Postman[78], the function of rumors is to substitute the formal news channels, e.g. at times of war. Although the approach in the studies on the phenomenon of rumor conducted by different researchers differs considerably (they have carried out laboratory and field experiments), there are several recurrent conclusions.

[76] J. G. Stappers, *Massacommunicatie: Een Inleiding*. (Amsterdam, 1983).

[77] Tamotsu Shibutani, *Improvised News. A Sociological Study of Rumor*. (The Bobbs-Merrill Company, Inc., Indianapolis, 1966). Page 121-125

[78] G.W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947), page 30

A useful definition of rumors for this stage of the analysis is the one that defines it as *an unconfirmed, uncertain and informal piece of news, which is normally passed on from person to person through informal channels of communication*[79].

Most of the studies about rumors start from the premise of diffusion through informal channels; however, according to some researchers, formal channels play a role although it is limited to that of initiator or mitigator of rumors.
The basis of Allport and Postman's studies, owing to the circumstances at the time of their research, is that rumors are rapidly born due to the lack of formal channels, as in times of war. As formal channels are non-existent, people try to satisfy their demand and need for news via an alternative channel. Therefore, they resort to informal channels, through which information and news are rapidly spread. This way of diffusion implies certain consequences on the contents transmitted due to the numerous stages of the news path going from A, through B, C etc, to finally reach D. On the other hand, it is very difficult to control the truthfulness of data in this process, i.e. how much the rumor resembles the original narration on the event in question.
Larsen[80] says that the balance of formal and informal channels is lost during a catastrophe. From his point of view, the role of formal channels is limited to starting or mitigating the rumor effect. The initiation is characterized by the lack or difficulty in access of formal channels, and mitigation occurs when the balance is restored. According to Peterson and Gist[81], the opinion-rumor is a special type of public opinion. It is not verified through the regular channels (i.e. formal channels), since the rumor cannot be confirmed by a specific authority. On the other hand, Peterson and Gist point out that rumor diffusion only occurs through social interaction, i.e. word of mouth communication instead of formal channels.
In his book *Communication and Culture*, Alfred Smith[82] says that in human communication, signs are transmitted through the human space passing through social and psychological distances. This human space is organized in networks, whose level of analysis is more advanced in the study of small social groups.
According to Buckner, rumor is spread through communication chains and networks. For rumorchains he mentions the use of informal channels; for rumornets, also called multiple interaction networks[83], the panorama is less clear: many people hear the rumor not from a single source but from many. These sources spread the rumor through informal channels. Buckner speaks of a network of interactions in connection with diffusion of rumors through interpersonal communication. Fauconuier[84], claims that in rumornets there may be

[79] G. Fauconnier, "Het Gerucht: Boeiend Maar Gevaarlijk", *Jaarboek Public Relations en Voorlichting*, (1991)

[80] O.N. Larsen, "Rumors in a Disaster", *Journal of Communication Nº 4* (Waterloo, Ontario, 1954).

[81] W.A. Peterson and N.P Gist, "Rumor and Public Opinion" , *American Journal of Sociology* (vol. 57 Nº 2, 1951)

[82] Alfred G. Smith, *Comunicación y Cultura*. (Buenos Aires, Ediciones Nova Visión. 1977).

[83] H. Taylor Buckner, "A Theory of Rumor Transmission"., *Public Opinion Quarterly Nº 29* (Chicago, Vol.1, 1965). page 68

[84] G. Fauconnier, "Het Gerucht: Boeiend Maar Gevaarlijk", *Jaarboek Public Relations en Voorlichting*, (1991)

transmission through formal or informal channels. However, Fauconuier´s perception is based on rumor transmission in organizations and cannot be directly connected with Buckner´s analysis. In his classification of rumor diffusion through *“class groups”* and *“extended groups”,* Buckner still mentions diffusion through informal channels, even when their presence is lower in extended groups than in class groups[85].

The first type of diffusion that takes place, according to Buckner can originate in either informal or formal channels (mass media). Let's take Dodd and Buckner´s analysis described by Buckner in his article *A Theory of Rumor Transmission*[86]. The case describes the spread of a rumor from fliers dropped from a plane as well as from interpersonal communication. In addition, there were individual and multiple interactions, and those who had received the rumor through multiple channels were capable of reproducing it in more detail.

Buckner´s study indicated that information was received sooner through mass media than through interpersonal contact. This means that both informal and formal channels play a role in rumor diffusion.

1.2.1 Informal Channels of Communication

When we speak about informal channels of communication we refer almost exclusively to interpersonal communication based on social interaction which, as a process of influence, plays a major role within the field of social psychology and rumor analysis. Above all, communication through social interaction refers to the reciprocal relation between two or more individuals whose behavior is mutually dependent[87]. Most of the behavior under observation is somehow influenced by previous or present social interactions.

The foundation of face to face communication lies in the social expectations which reside in the psychological field and are to a great extent related to the prior experiences of individuals. Those expectations guide them to produce certain results of interdependent behavior and to allow an evaluation of those results.

Also, social interaction constitutes a transaction which implies a social exchange process. In general, interaction works in terms of reciprocity, i.e. the expectation that the benefit offered will be compensated (for example, the power or status granted by the fact that someone knows something unknown to the rest).

The level of interaction is such that someone shows certain behavior in the presence of others. Consequently, each of them can do or say things that will be rewarded by the other. However, the value of the reward depends on the particular demands of the participants. These rewards are balanced by the costs of interaction in terms of the values given as compensation or resigned values. It is worth mentioning that according to Allport and Postman, rumors are originated not only in the individuals’ needs and impulses but also specially in their interests.

Neither mass media nor telecommunications -with their increasing social implication- have replaced oral transmission as the main vehicle for rumor diffusion. In the same way that

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[85] H. Taylor Buckner, “A Theory of Rumor Transmission”, *Public Opinion Quarterly Nº 29* (Chicago, Vol.1, 1965).

[86] H. Taylor Buckner, *op. cit.*

[87] Edwin Hollander, *Principios y Métodos de Psicología Social* (Buenos Aires, Amorrortu editores, 1982, 3rd edition), page 28

new media which appear in the social system do not simply replace the existing ones, but readjust their functions in a symbiotic process, interpersonal communication complements the transmission system dynamics.
Communication through informal channels basically stems from social interaction. The interaction concept has several meanings, depending on the science of application. Goertz lists out a series of examples in medical science, linguistics, statistics or engineering. In interaction, there is a communication process which influences individual actions and perspectives. In general, social interaction comprises what Schutz calls "an interpersonal situation", i.e. a situation where two or more people interact with a certain purpose. However, these interpersonal situations do not necessarily involve emotional face to face relationships. The actions of a person can be determined by the expectations of others who are not physically present at the time. For example, the members of a family separated by kilometers still keep a fluid interpersonal relationship.
Informal communication through face to face contact is the most frequent. Expectations differ when interaction occurs on a long-term basis rather than in the short term, e.g. when two people meet on a trip and they do not get to know each other very well. In the first case, a long interaction process, there is a behavior interdependence between the parties, and the behavior of one of the parties is the stimulus for the other. On the other hand, there is a mutual behavior expectation in the sense of reciprocal interpersonal perceptions. According to Hollander[88], a third characteristic adds to these two features: implicit evaluation, and it refers to the value given by an individual to other people with whom he interacts and communicates, the analysis of their actions and motivations, as well as the satisfactions they provide. This evaluation is conclusive factor to decide on sharing and re-transmitting a rumor, or not.
There are situations where communication through informal channels – as a way to generate and strengthen social interaction- reduces the effect of tensions. In his work *Psychology of Affiliation*[89], Stanley Schachter claims that college students show stronger desire to establish contacts with others of their same condition. In turn, research conducted at times of war by D. G. Mandelbaum and by S. L. A. Marshall, proved the importance of interaction and informal communication among soldiers to resist the stress of combat. Let's bear in mind, as proven by Allport and Postman, that rumormongering becomes specially virulent when there is tension in the social surrounding.
The level of *functional interdependence* among the parties is a significant element in person to person communication. The concept refers to the extent to which individuals need each other to obtain rewards which would otherwise not be obtained. This is cooperative interdependence. Another type of interdependence is that of competition, where the goal can be achievable for only one person. The tendency to share a rumor basically takes place in the case of cooperative interdependence, since it depends on the level of trust that the participants have for one another.
In his article *A Theory of Cooperation and Competition*[90], published in 1949 in Human Relations magazine, M. Deutsch contributed several useful findings and premises to understand the concept of cooperation. Among them is the idea that cooperation increases as people recognize their mutual interdependence and encourage a reciprocal feeling of

[88] Edwin Hollander, *op. cit.*

[89] Stanley Schachter, *The Psychology of Affiliation* (California, Stanford University Press, 1959)

[90] M. Deutsch, "A Theory of Cooperation and Competition", *Human Relations* (vol. 2, 1949), pages 129-152

trust. Deutsch conducted extensive experimental work on these circumstances, often employing the choice matrix known as the Prisoner's Dilemma.

Persona II

	Option X (trust)	**Option Y (no trust)**
Option A (trust)	(I) + (II) +	(I) – (II) +
Person I		
Option B (no trust)	(I) + (II) –	(I) _ (II) –

The name of the matrix comes from the analogy with the situation where two people are under arrest for a crime and are questioned separately by the police, without allowing them to speak with each other. They are both told that if they provide evidence to sentence the other one, they will benefit from a more benign decision. By analyzing the matrix, it is possible to see the preference towards A or B in person I, and towards X or Y in person II. Assuming that A and X indicate the decision not to provide evidence, it is obvious that both individuals will benefit. If I chooses Y to provide evidence for his benefit, and II chooses B with the same purpose, both will lose, since they have mutually accused each other before the authorities. However, if they trust each other, they will answer A and X respectively and they will both benefit; if they do not trust, they will answer B and Y and they will lose. If one trusts but the other does not, the one who trusts will be harmed.
With this type of matrix it is possible to test in a two-person situation the likelihood for a rumor to be believed and thus passed on, since the individual who perceives credibility is likely to pass it on to others. If instead he does not trust the one who transmits it, he will be prone to think he is being taken in; therefore, he will not re-transmit it to avoid ridicule or to avoid playing his interlocutor's game [91].
We will refer back to the Prisoner's Dilemma in the last chapter.

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[91] According to Brown: "Behavior in politically intricate situations is attributed to higher level of political information, a deeper understanding of the game's rules, or superior strategies, and of course lots of information (or at least enough information so as not to be duped). Nearly all published theory on the iterative prisoner's dilemma fits into this category."
Thad A. Brown, "Nonlinear Politics". *Chaos Theory in the Social Sciences: Foundations and Applications.* In Douglas L. Kiel, and Evel Elliot (edit), University of Michigan Press, 1997. Page 122.

1.2.1.1 Domination and Power of Interaction

In general, someone's dependence on another increases the likelihood of influence. Domination represents a type of interdependent relationship which increases acceptance of someone's influence. It can be conceived as a relationship implying power. Robert Bierstedt[92] has made a distinction between influence and power on the basis of the opposition between persuasion and coercion. He says that influence is not dependent on power which in turn, can do without influence. Influence can transform a friend, but power coerces both the friend and the enemy.

Therefore, on one extreme, the presence of usable power implies a situation of coactive domination. Influence consists of the transmission of information destined to modify the response patterns of one or more individuals whose response perception comprises more than one alternative. However, if the transmitter agent has power, the only alternative perceived is generally to comply with what is ordered. This does not imply the credibility of what is being transmitted, so if it is a rumor, the mere power of the transmitter does not imply its re-transmission on the part of the interlocutor. On the contrary, if the informer exercises influence on him -e.g. an opinion leader- the likelihood of retransmission will be much higher.

1.2.1.2 Interpersonal Attraction

An essential aspect of informal channels of communication is the attraction-rejection dimension of communication agents, i.e. the opposition liking - disliking. It is evident that liking or disliking someone influences the starting and continuation of communication. Social psychology has traditionally conceived attraction as a mutual game of individual dispositions that may be influenced by situational factors, such as social structure and physical proximity. Moreno[93] highlights the importance of interpersonal attraction and rejection as basic features of interaction and communication among individuals.

Some authors oppose attraction, completely affective, to credibility, of a cognitive nature; but this deep opposition does not take into account that certain components of credibility (bias, lack of desire for personal profit, intention to deceive or manipulate) also possess an affective connotation. As with credibility, one can wonder if attraction is a unitary notion: the source of a rumor can prove attractive either because it is familiar, because it is similar to us, or because it is very famous. In his work *Relations Analysis*, R. Tagiuri, quoted by Edwin Hollander[94] says: *"no other characteristic in others seems to involve the self so much as positive and negative attitudes towards us (...) Certainly, when other factors are equal, and when the differentiation of roles within a group is not very stressed, the like-dislike category governs most of the determinants of the interaction (...) It is as if like and dislike summarized a diversity of many other components".*

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[92] Robert Bierstedt, "An Analysis of Social Power", *American Sociological Review* (vol. 15, 1950), pages 730-38.

[93] J. L. Moreno, "Foundations of Sociometry, An Introduction", *Sociometry* (vol. 4, 1941), pages 15-38

[94] R. Tagiuri, "Relational Analysis: An Extension of Sociometric Methods with Emphasis upon Social Perception", *Sociometry* (vol. 15, 1952), pages 91-104; cited by Edwin Hollander, *Principles and Methods in Social Psychology.*

Common sense indicates that *liking* someone leads to accepting their point of view. This is the basic principle of the *cognitive consistency theory*[95], which states that an individual tries to match the feelings he/she has for someone with their level of agreement with that person's opinions. Hidder's *Balance model*[96], which is known in specialized literature as the "P-O-X Model", states that if a person (P) knows he likes a person O and they share their opinions about the same object X (either positive or negative), the three elements are balanced; if P does not like O and they do not coincide in their opinions about X, the three elements are balanced as well. On the contrary, if P likes O and their opinions are different, one positive and one negative, there is no balance and the individual will try to find balance by, for example, changing his opinion about X. This model has been the object of a number of experimental validations (Insko, 1974 and Kinder, 1978) with positive results.

Competence or attraction play their roles independent from one another: a competent source has an impact on the recipient, regardless of its attraction. The same happens with an attractive source, regardless of its competence. The effects of both qualities are cumulative. The second aspect is related to the joint effect of the source factors with the message and recipient factors. The competence effect seems to depend on the type of object and type of social problem of the message, specially among intelligent, well-learned and high-social level individuals. It also depends on the importance given by the recipient to the problem in question (personal implication) and the firmness of his personal position (extremism) towards the issue. In addition, it varies according to the degree of disagreement between the position of the source (or rumormonger) and the recipient, and finally, according to the nature of the arguments used in the message (fear as a resource, for example). The level of trust also depends on the message (argumentative resources) and the recipient: men are often more suspicious than women, the same as individuals with a high self esteem (Montmollin[97]).

It is almost sure that the source factors directly participate in the message evaluation. It has been experimentally shown that a competent source steers a lower counter-argumentation in the recipient. This is because the position adopted and the arguments that support it are judged valid; therefore, the recipient accepts the validity of the position from the source.

On the other hand, the evaluation of the message can -indirectly- discredit the source or rumormonger. Too much emphasis or intensity, unilateral argumentation, an explicit conclusion deemed as redundant, an extremely opposite opinion, a far too intense appeal to fear, etc. are factors which can appall the recipient and turn him against the source/transmitter who is then perceived as manipulative or threatening. It results in discredit and lack of credibility for the source's arguments.

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95 R. P. Abelson and M. J. Rosenberg, "Symbolic Psycho-logic: A model of Attitudinal Cognition", *Behavioral Science* (vol. 3, 1958), pages 1-13; cited by Edwin Hollander, *Principles and Methods in Social Psychology.*

96 Fritz Heider, *The Psychology of Interpersonal Relations* (New York, John Wiley and Sons, 1958); cited by M. Deutsch and R. M. Krauss, *Teorías en Psicología Social* (México, Paidos, 1997), pages 37-41

97 Germain de Montmollin, "El Cambio de Actitud", in S. Moscovici, *Psicología Social I: Influencia y Cambio de Actitudes/ Individuos y Grupos* (Buenos Aires, Paidos, 1984), page 131

If, as indicated by some of Montmollin´s results, credibility and attraction have an independent effect one from the other, it should be assumed that attraction participates in the evaluation in a different way than competence. Being attracted by someone implies the need or wish to agree with them; the agreement with the source is valued instead of the validity of his point of view. Therefore, the recipient evaluates the anticipated consequences of his agreement or disagreement with the source and can expect further satisfaction out of his agreement with a pleasant, prestigious or admired source.

A problem that has caught the attention in attraction-oriented research can be summarized with the following proverb: “Birds of a feather flock together”. In technical terms, it refers to the resemblance hypothesis.
This resemblance hypothesis can be reflected in problems related to friendship, where those who feel mutually attracted are prone to express similar attitudes, values and interests. This mutual attraction is increased by a similar universe of discourse which makes social communication easier. In other words, those who share similar ways of thinking, help rumor diffusion.

Organizations, as mentioned before, have a system of formal channels of communication. This formal system provides the employees with information about the organization to through different means. The data transmitted through rumors is not documented, so the possibility of change is very scarce. *“The informal organization through social interactions is less permanent and less stable (than the formal organization) because its leaders and action patterns can change suddenly. This happens because the network depends on the personalities, while the formal channel network is established by means of structured policies which do not depend on individuals”* (Simmons[98]).
In 1953, the American researcher specialized in organizational behavior Keith Davis, who based his analysis within the corporate framework, conducted a classic rumor analysis, followed, in turn, by extended research by Harold Sutton and Lyman Porter in 1968. According to Davis[99], *“rumor is a natural part of the corporate communication system (...) it is a significant force within a working team which helps build team work, motivate people and create corporate identity”*. In this sense, rumor is the passing of informal data through informal channels of communication company-wide. It does not necessarily follow the organization’s structure and can overlook individuals without any limit. It can be quicker and more direct than formal channels of communication since the information is not controlled.
In general, it does travel more rapidly than through formal channels.

Since rumor derives from social interactions, it is as changeable, dynamic and diverse as people. In this sense, it is the expression of the natural motivation to communicate and the exercise of free speech.

According to Davis, the informal channel of rumor (the *secret channel*, as he calls it) contains four different chains/ structures which seem to dominate the network[100]:

[98] Donald S. Simmons, “How Does Your Grapevine Grow”, *Management World Nº 15*. (February, 1986)

[99] Keith Davis, “Communication Within Management”, in William A. Nielander and Max O. Richards, *Management.* (Cincinnati, 1969)

[100] Keith Davis, “Grapevine: Communication Among Lower and Middle Managers”, *Personal Journal.* (April, 1969)

The first is the *thread chain*. It is a simple concept: A tells B, who tells C who in turn tells D, and so on. Each person passes the information on to the following. The longer the chain, the more distorted and filtered the information, according to Allport and Postman's criteria, until the last person of the chain discovers that the information is unrecognizable compared to the original message. Most inaccuracies occur in this chain.

The second is the *gossip chain*. Here, A simply tells everybody around. This pattern is considered somewhat slow in the flow of information.

The *probability chain* is the third type in Davis' classification. In this case, A randomly contacts F and C and passes on the information following a linear model. In turn, they contact others according to the laws of probabilities (we come back to this point in the third part). Some get to know this information and others do not. In this structure, there is no definite communication pattern. Information is passed on at random to whomever wishes to hear it. The type of people who communicate in this way can be very extroverted and talkative.

Finally, the last type is the *group chain*. A tells B and F, who work with A. They can pass on the rumor to two or three people with whom there is close contact and thus the chain starts to branch out. The predominant pattern is the group pattern. Selectivity is the basis of this pattern. According to Davis, in any organization, individuals will feel more comfortable with their coworkers and will therefore pass information on to members of socially informal groups. This flow pattern prevents information from reaching some individuals.

1.2.2 Formal Channels of Communication

For the purposes of this analysis, mass media are considered to be the fundamental formal channels. However, this concept is not exclusive, since other channels like institutional media within an organization or "fliers" are also included in this category.
Although rumor is a type of interpersonal communication, it is true that press -since it was born- has intensively used the source of unconfirmed reports. In fact, mass media, its growth and increasing penetration have speeded up rumors, thus drastically reducing their life[101].
An increasing part of mass media lives out of rumors. From the Argentine newspaper "Ámbito Financiero" (in the section *Barbacue Chats*) to the Wall Street Journal, mass media devote complete columns to spreading different types of rumors. However, it is worth mentioning that several media, specially magazines and "talk shows", usually spread gossip instead of rumors.

Press and rumors share popularity and attention since they both transmit attractive news. Unlike regular information, a piece of news is characterized by being current and by its strong affinity with the interest of the public since it reports events, circumstances, issues and topics which although unexpected can bring about significant consequences for the public.

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[101] Andreas Würgler, "Fama und Rumor. Gerücht, Aufruhr und Presse im Ancien Régime", *Werkstatt Geschichte Nr. 15*. (Hamburg, Ergebnisse Verlag, December 1996).

In his article "*The Black Market of Information*", Stephan Russ-Mohl[102] wonders: *"don't we expect a serious professional reporter to proof the truthfulness of news and rumors before publishing them? Sure, because once a rumor has been put in circulation it becomes a piece of news. Any stockbroker can "sing a song" about how many times the spread of a rumor has caused their profits to increase."*
He continues: *"This is not enough, however, to explain and justify the reason why today mass media spread rumors so lightly and excessively. Can it be that they are thriving because the line between journalism and entertainment is getting more and more blurred? Research (of the information) is very expensive. Rumors and gossip -erroneously called "Talk" in the new journalistic jargon- are cheaper to distribute and their entertaining value is often higher than proven facts and deep field analysis in the competitive pursue of "ratings".*

1.2.2.1 Rumor and Gresham Law

In the field of the theory of economics, the *Gresham Law*[103] is absolute: bad currency replaces the good one. Tomas Gresham, Queen Elizabeth I´s chancellor and economic advisor expressed his theory in this way: *"in all countries with two currencies in circulation, the bad one will always take the place of the good one".*
Something similar happens in the field of communications. If, given a fact of interest, it is intended to hide information, fragment it or defer it for various reasons, this intention will clash with the needs and demands of the public. Then, in view of the lack of accurate and reliable information, mass media and individuals will resort to any available source to satisfy their needs. In the case of media, errors, omissions and false prints that may be incurred due to the lack of direct sources are rapidly spread. There is no ill will or bad intentions involved. The problem is simply that nobody wanted to speak or took the time of responding to the reporter's requests. This is the bad information, the rumor, which replaces good information, as in Gresham Law. In other words: rumors are substitutes for true information when the demand for information is not covered.

In 1936, in his "General Theory of Occupation, Interest and Money", one of the most important works of economy literature, John Maynard Keynes wrote: *"Mass Psychology, about a large number of ignorant individuals, is subject to violent modifications due to violent changes of opinion resulting from factors which are actually meaningless".*
In October 1997, a financial run in Thailand brought about a huge economic crisis worldwide. In the era of globalization, this crisis proved how rumors spread instantaneously through the IT tele-channels open anywhere anytime. In this sense, globalization, as never before, has displayed the use of formal channels for rumor diffusion.
The crisis in question, illustrated on "The Economist" cover of November 1, 1997 by a typical rumor diffusion chain- the characteristic "Chinese whispers" effect- was described by the magazine like this: *"a panic-filled market leads operators from other markets to act*

[102] Stephan Russ-Mohl, "Schwarzmarkt der Information. Vom ältesten Kommunikationsmedium der Welt". in: *Tagesanzeiger (newspaper).* (Zürich, April 29, 1996).

[103] Edgardo Silberkasten, "Ante el Silencio, la Mala Información Siempre Reemplaza a la Buena", *El Cronista* (Argentine Newspaper - June, 1995) Management Section, page 1.

as frightened gazelles which frantically escape from a lion, although they have no idea what is danger is or where the lion comes from ".

The Economist magazine, November 1, 1997. In the era of globalization, this crisis proved how rumors spread instantaneously through the IT tele-channels open anywhere anytime.

1.2.2.2 "Fliers" as Formal Channels

Since 1980 Kapferer has been analyzing a rumor he initiated through a flier which claimed that certain food additives contained deadly substances[104]. The research team distributed 500 of these fliers through mailboxes in homes in Rennes, France. A week later, a survey was conducted involving 150 housewives from these homes. When the interview ended, this 150 housewives received the official rectification of the content of the flier.
Since more than 350 homes failed to receive this rectification, they reportedly started to show strong signs of uneasiness; therefore, authors such as Smith and Koenig wonder whether the ethical code of the American Association for Public Opinion Research was violated.

The rumor launched by Kapferer did not go through the conventional channels: *"a contaminating rumor has been circulating around France for over ten year. In spite of the official effort to refute it, not only has the rumor passed on from mouth to mouth but also from hand to hand in the form of a flier"*[105]. The carrier of this message was formal (flier process), but its diffusion was person to person. A nationwide survey conducted in 1983 showed that a certain number of people had found the flier in their mail box or had received it at the door of a school, bank, supermarket, factory, office or hospital. In 3 years, 43% of French housewives had read the "Villejuif flier". It is striking, however, that 11% of the people surveyed said they had learnt about the rumor through the press. They did not refer to the national press, but to regional and local bulletins and specialized magazines. In addition, the flier was published in books in two opportunities.

1.2.2.2 The "J" Diffusion Model

This communication model, unlike others which stress the influence factor (persuasion) over attitudes and behavior, underlines the importance of interpersonal or informal channels for the transmission of news and information through mass media or, according to Mc Quail's words[106], *"news dissemination measured by the capacity to remember certain events highlighted (by mass media)".* This model not only allows the measurement of short-term effects but also long-term effects in connection with variables related to news impact, personal interest and social support. Therefore, the following variables are to be considered in the analysis of the impact of information on the public: a) what people know about a certain event; b) the relative magnitude or publicity of the event in question; c) the volume of information in connection with a piece of news and d) whether the information comes from published news or personal contacts.
The model, proposed mainly by B. S. Greenberg[107], tries to link the variables listed above and results in a "J" shaped curve. In the case of those events which are of little importance

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[104] Jean-Noël Kapferer, *Rumors: Uses, Interpretations & Images* (New Brunswick and London, Transaction Publishers, 1990), pages 34-35

[105] Jean-Noël Kapferer, *Rumors: Uses, Interpretations & Images* (New Brunswick and London, Transaction Publishers, 1990)

[106] D. McQuail, *Sociología de los Medios Masivos de Comunicación*.(Buenos Aires, Piados. 1972).

[107] B. S. Greenberg paper (1974) is cited by Cándido Monzón, *Opinión Pública, Comunicación y Política* (Madrid, Editorial Tecnos, 1996), page 250

for the majority, the people interested will resort to personal information to access the desired information, i.e. they will use informal channels. In the case of widely spread events of general interest, most people will receive the data from mass media (formal channels), and for those of great interest due to their exceptional nature (as Kennedy's assassination, for example), many individuals will receive or confirm the news via other people, despite the wide diffusion by the media. In this case, the importance of the event mobilizes not only formal and informal but also fosters rumor diffusion.

Almost every social interaction is based on the fact that we trust others and that we give some "senders" the mission of corroborating the data they make available to us. As individuals insert themselves in the globalized world and obtain information through mass media, their level of concrete knowledge is lower and their dependence on "serious" sources and believable contexts gets higher. Although "official" information is intended to avoid rumors, this intention does not automatically equal credibility; on the contrary, it is a strategic tool for politics to influence public opinion[108].

According to Kapferer[109], during the Gulf War, despite the 24-hour coverage by the mass media, rumors increased because the press was subjected to prior censorship in situ and was used with propaganda purposes. In spite of the media coverage, the international public opinion demand for true information grew sharply and gave way to various rumors.

The "J" diffusion model, besides its immediate application in all critical situations where the information obtained from mass media and social interaction is essential, shows the different information and communication paths employed by people, the exposure and credibility allocated to the media by the citizens, the importance acquired in certain cases by informal communication, and specially, rumor and group dependency on mass media[110], from the point of view of span and intensity. In 1948, an American researcher from the *Communication Research School*, Bernard Berelson pondered on the knowledge available by that time and reached this sharp and even capricious conclusion: *"certain communication issues related to certain topics, under the attention of certain types of people under certain types of conditions have certain types of effects[111].* A contemporary researcher, Joseph Klapper[112], states, however that regardless of whether mass communication has individual or social effects of mass communication, the media are likely to reinforce rather than change the existing conditions.

In his study at the Applied Social Research Department at Columbia University, Elihu Katz determined -through several successive studies conducted in order to examine how interpersonal communication networks absorb the influence of mass media, thus

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108 Jean Nöel Kapferer, *Rumores. El Medio de Difusión más Antiguo del Mundo*. (Barcelona, Plaza & Janes Editores. 1989). (For the present work, the German edition was also used: *Gerüchte. Das Älteste Massenmedium der Welt* , Leipzig, Gustav Kiepenheuer Verlag. 1996).

109 Jean Nöel Kapferer, *Rumores. El Medio de Difusión más Antiguo del Mundo. Op. cit.*

110 Cándido Monzón, *Opinión Pública, Comunicación y Política* (Madrid, Editorial Tecnos, 1996)

111 Bernard Berelson, *Content Analysis in Communication Research*. (New York, Free Press. 1952).

112 Joseph T. Klapper, *What we know about the Effects of Massive Communication: at the Gates of Hope*. Published by Alfred G. Smith, (edit.), *Comunicación y Cultura*. (Buenos Aires, Ediciones Nueva Visión. 1977), page 211

increasing or decreasing its effectiveness- that the influence of interpersonal communication seems to be more effective than that of mass media. According to his research, those who adopt an innovation or an opinion tend to rely on “the other people” who influenced their decisions. In this sense, communication resulting from social interaction plays a major role, in contrast with formal channels.

However, when decision-making is broken down into phases (data capture, awareness, interest, evaluation, acceptance of a decision), mass media appear as a relatively greater influence in the first information phases, while personal influences are more effective in connection with consideration and decision.

Rosnow (1974) reached the same conclusion. He claims that the first stage of the rumor phenomenon is the genesis (he calls it “parturition”) followed by diffusion and control[113]. According to him, genesis takes place either deliberately or spontaneously, and diffusion immediately follows. In Rogers´ words diffusion is the *“process by which innovations are spread to the members of a social system throughout time”[114].*

With this perspective, already in the phase rumor origin, formal and informal channels can play a role, which means that if we consider Rogers´ definition of diffusion, they participate from the inception of the diffusion development. Genesis and diffusion show a certain overlapping based on conceptual inaccuracies: Rosnow is unclear as to when the “*parturition*” phase ends and the “*diffusion*” starts.

Although in most existing studies the analysis of rumor diffusion is virtually limited to interpersonal communication, it is possible to imagine that the messages transmitted by formal channels influence rumor diffusion. Several authors like Rosnow claim that the last phase of rumor diffusion (control) comes to an end due to formal channels, i.e. when formal channels are eventually employed, rumors quiet down or die[115].

Larsen[116] is another author who attributes formal channels the role of rumor conclusion instruments. If this is so, the following question arises: what happens when the messages spread by formal channels to eliminate rumors do not achieve their goal completely? Do they strengthen, mitigate or distort rumor? Whatever the case, it is evident that rumor diffusion is influenced by official channel diffusion.

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[113] Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976), pages 22-49

[114] Everett M. Rogers, *A History of Communication Study. A Biographical Approach.* (New York, The Free Press. 1997)

[115] Rosnow says that “however, there are some rumors, which never die” and to prove his point he gives the example of the rumors circulating around the assassination of USA President J.F.Kennedy: “How a rumor dies depends on the nature of the tale within the social context. Some rumors never die, but become part of the established popular belief structure. Thomas Carlyle once characterized history as ‘a distillation of rumor.’ Some rumors become so deeply enmeshed in the web of recorded history that they cannot easily be excised. John Kennedy’s assassination produced a spate of rumors, many still alive in the hearts and minds of those disinclined to believe the findings of the Warren Commission. Leaving aside the justification of these rumors, it is not unreasonable to forecast that a hundred years from now stories will still be circulating about that fateful November day.” Ralph L. Rosnow and Gary A. Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976). Pages. 42 and 43.

[116] O.N. Larsen, “Rumors in a Disaster”, *Journal of Communication* Nº 4 (Waterloo Ontario, 1954).

1.2.2.3 Rumor as a Form of Public Opinion

Peterson and Gist consider *opinion-rumors* a special case of public opinion[117]. They claim that rumor differs from other types of public opinion because its content cannot be verified through formal channels. However, they define rumor as a collective attempt of interpreting a conflictive and affective-sensitive situation; therefore, formal channels are not excluded.
Perhaps rumor is not verifiable, but this characteristic says nothing about the other roles of formal channels in diffusion. This is evident if we approach the concept of public opinion from Davison´s (1962) *public opinion process*. He defines public opinion as *"the one connected with the action or readiness for action related to an issue involving how a part of the public reacts driven by the expectation of other group members who share their views towards the issue in question"*[118]. He distinguishes seven steps in the public opinion formation process, among which mass media play a role (and therefore formal channels). Mass media hold a specially important role when an opinion is being spread by opinion leaders within a group and when diffusion among groups occurs. Consequently, it is likely that the same holds true for rumor diffusion, since they are -as we said before- a type of public opinion.
To summarize, it can be concluded that the role of formal channels in rumor diffusion is limited and that informal channels play the leading role in transmission. The role of formal channels is limited to the initiation and conclusion of rumor diffusion (Allport and Postman, Larsen, Buckner). Only one author (Kapferer) goes deeper in the role of formal channels: according to his research, a flier can spread a rumor. On the other hand, the role of formal channels in the origin of rumors depends on the definition selected for the concept of diffusion. According to Rogers' definition, the role of formal channels can be important in the diffusion process. Rosnow is not clear as to the end of genesis and beginning of diffusion. Anyway, formal channels influence rumor diffusion. Both Rosnow and Larsen attribute great power to formal channels in this respect. If a message through a formal channel can end a rumor, it is obvious that a wrong formulation of this message may influence it differently, for example reinforcing, mitigating or simply distorting its content.
Finally, authors such as Peterson and Gist consider rumor a form of public opinion. If the concept of public opinion is viewed from Davison´s perspective, rumors are also spread through formal channels, i.e. mass media.
As may be inferred, these authors have a different perspective. As is the case of many trends in research, there is lack of a solid theoretical foundation in order to compare the different studies.

1.2.3 Internet as Formal and Informal Channel

Internet is an open and distributive technological system. Distributive means that it has no central location; open means that the operating codes are neither secret nor owned by anybody.

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[117] W.A. Peterson and N.P Gist, "Rumor and Public Opinion" , *American Journal of Sociology* (vol. 57, Nº 2, 1951)

[118] W. P. Davison, "The Public Opinion Process", in R. M. Christenson and R. O. Mc Williams (Eds): "Voice of the People". In: *Public Opinion and Propaganda*. (New York, McGraw Hill. 1962).

There is a genetic relation between Internet's main technology and its most important cultural characteristic. Any introduction of a new technology in society implies a latent systemic impact which resembles how genes pre-determine most part of human physiology and psychology.
Whenever any radically different technology has a strong penetration in society, as Internet, it will also penetrate -in the same magnitude- the economic and political structures of the adjacent cultures. As these cultures start integrating Internet in their social structures, they gradually adopt the systemic characteristics of the Net[119].

Internet's open and distributive technology has created, almost by accident, an entirely new massive and bi-directional way of human communication-participation and now we frequently make references to the "Internet culture". The Net is a new way of communication, and communication in turn is the foundation over which every culture is built; therefore, by introducing a new way of communication a new cultural paradigm is created.

The hypothesis that the Earth is a homeostatic system was given the name of Gaia, the Greek goddess of the Earth by the British scientist James Lovelock in 1972. The author describes this concept like this: *"The whole range of living matter on Earth -from whales to viruses, from oak trees to seaweed- can be considered an element of a living entity, capable of manipulating the earth atmosphere to adjust it to its needs, with much greater powers and faculties than those of its constituent part ".* In turn, the futurist Jerome Clayton Glenn has postulated that in the near future the Earth will have as many inhabitants as nerve cells there are in the human brain. And by then in some mythical way, humanity will create a collective conscience which will "awaken" the planet. In this book *Cyberia*, Douglas Rushkoff merges Lovelock´s hypothesis, Clayton´s fantasies, the theory of chaos and McLuhan´s ideas to imagine a world interconnected by a digital communications network which would be "the last phase of Gaia's development".
Manuel de Landa, Mexican post-modern philosopher and publicist, speculates on these ideas in "War in the Age of Intelligent Machines" by saying that the Internet's uncontrolled growth could translate into the surge of a global artificial intelligence. He writes: *"Surpassing a certain threshold of connectivity, the membrane created by computer networks on the earth surface is becoming alive".*
In his work *Out of Control*, the editor of Wired magazine Kevin Kelly also perceives this strange quality in the Internet. *"The Net is the least structures organization with that can be considered structured. It can be rearranged endlessly and grow in any direction without altering its basic shape, although it really lacks any defined outside shape"*. According to him, the network of networks can also generate an intelligent super-organism, able to resolve new problems, evolve and have its own goals. *"The mystery of the invisible hand is hidden in the Net".*
William Morton Wheller, expert in ant behavior, gave the name of super-organism to the cooperation in colonies of certain insects. A super-organism emerges from the mass of ordinary insects, although it can appear in groups of other animals, such as birds and lemurs- and also appears in inanimate bodies (as in water whirls). As will be seen in the third part of this work, chaos theorists gave the name of singularities to the transition points where order emerges spontaneously from chaos as a catalyst of seemingly living behavior in dead matter.

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[119] Michael Strangelove and Aneurin Bosley, *How to Advertise on the Internet.* (USA, Strangelove Press. 1994)

A flock of birds is not a big bird, a beehive is not a huge bee; both are examples of super-organisms formed by numerous individuals where there is no leader; however, there is an invisible hand which leads the mass. This happens with the Net and is known as the "spirit of the beehive". In his *General Theory of Systems*, Ludwig von Bertalanfy[120] concluded that the behavior of the whole is not determined by that of its individual constituents; Kelly goes beyond this and writes the following about Internet: *"What emerges from the collective is not a series of critical individual actions but a multitude of several simultaneous actions whose collective pattern is more important than its parts. This is the beehive model"*[121]*.*

Leaving aside the description from the philosophical, technological or sociological point of view, the truth is that the Internet, which is doubling its size every year, has fallen from heaven like a bomb and has exploded in the middle of the popular culture scene[122].

From the point of view of the communication theory, perhaps the most discussed issue related to the Internet is the *social communication mass media* concept. As known, the term is connected with a metaphor about communication carriers applied by Shannon and Weaver in the 40´s.

Shannon and Weaver´s communication model[123], or, more precisely, theory of information is conceived in function of cybernetics (the study of the operation of machines, specially electronic ones). When Shannon speaks about information, he links the terms to a completely different sense from that of social communication science. He considers it a quantifiable unit which does not take into account the content of messages.

In essence, their model allows to study the amount of information of a message in function of the capacity of the environment. This capacity is measured according to the binary system, i.e. in bits associated with the speed of message transmission, which can be reduced by noise. As is known, the elements of Shannon and Weaver's model are the source, the transmitter, the channel, the recipient, the addressee and the noise. Weaver later adapted this model to psycho-social communication[124].

Based on his studies, the Mass Communication Research lines consolidated in the 50´s, when Wilbur Schramm[125] and Paul Felix Lazarfeld[126] played an important role in making it known.

Maletzke[127] brings back Shannon and Weaver's model by defining "mass communication" as *"the way a message is publicly transmitted (i.e. non-restrictively and non-nominatively)*

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[120] Ludwig Von Bertalanffy, *General Theory of Systems*. (México, Fondo de Cultura Económica. 1968, in Spanish).

[121] Kevin Kelly, *Out of Control, op. cit.*

[122] Michael Strangelove and Aneurin Bosley, *How to Advertise on the Internet.* (USA, Strangelove Press. 1994)

[123] C. Shannon and W. Weaver, *The Mathematical Theory of Communication*. (University of Illinois Press, 1949)

[124] C. Shannon and W. Weaver, *op. cit.*

[125] Wilbur Schramm, *The Process and Effects of Mass Communication*. (University of Illinois Press, 1954)

[126] P. Lazarsfeld and R. Merton, *Mass Communication, Popular. Taste and Organized Social Action.*. En: L. Bryson, *The Communication of Ideas* (New York, Harper. 1948).

[127] Gerhard Maletzke, *Psychologie der Massenkommunikation*. (Hamburg, 1992)

through technical channels of diffusion (media) in an indirect way (through space, time or space-time between source and addressee) and unidirectionally (without a sender-recipient role exchange) to an extended audience ".
For Strangelove[128], Internet is no doubt a social communication mass media. He says it is a new form of social communication. In his opinion, mass communication -a relatively new phenomenon in itself- has always meant a controlled transmission to passive audiences, which have never influenced or controlled the content of mass communication. Internet has radically changed this. The number of individuals who transmit to a massive audience is equally massive.
While Guttemberg's mobile type printer made mass communication possible for the few owners of the then new printing machines, each user of a computer connected to a telephone line (via modem) has become an editor, a radio operator or, in the near future, the owner of a television channel thanks to the Internet.
In this respect, we are participating in a real process of mass communication democratization. On the other hand, this communication is two-way and not subjected to any type of censorship. In the Net, anybody can say what they want. The only restriction to freedom of press in the cyberspace is that the conversation (either oral or written) is to respect the rules of any on-line conference, but in no way does this reduce the role of Internet as the first forum of censorship-free mass communication and its role as "*the last reservoir for freedom of speech*"[129].

Throughout history, mass communication has always been subject to the strict control of the governing elite. In the past, crowds and mobs were perceived as a threat for rulers and therefore were quickly and violently eliminated. In modern times, all mass media are either owned or controlled by the State directly or indirectly through regulatory entities. On the other hand, even the private activity somehow exerts some control through advertising, which defines which programs are economically feasible and which ones are not.

As a "public resource", the Internet has succeeded in avoiding the State control (National States is more appropriate), as well as the capitalist dynamics of privatizations and the subsequent multimedia empires. Proof of this is the May 1988 U.S. lawsuit against Microsoft on the grounds of monopoly attempt.

Although today the concept of information is not so much regarded in its formal sense, but rather as a process for the construction of meaning in the individual mind, Maletzke's concept of mass communication, regarding its function, is still a commonplace for the different theories of communication. An example is the importance given by Schmidt[130] to media organizations, structured as publishing companies, radio stations and television stations; for the author of this work, they make up a *system* of mass media.

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128 Michael Strangelove, *op. cit.*

129 Michael Strangelove, *op. cit.*

130 See on this issue these two works:
Schmidt, Siegfried J.: *Die Wirklichkeit des Beobachters*. In: Merten, Klaus, Schmidt, Siegfried Y Weischenberg, Siegfried edit.: *Die Wirklichkeit der Medien. Eine Einführung in die Kommunikationswissenschaft.* (Opladen, 1994)
Schmidt, Siegfried J.: *Konstruktivismus in der Medienforschung: Konzepte, Kritiken, Konzequenzen*. In: Merten, Klaus; Schmidt, Siegfried J. Y Weischenberg, Siegfried; (edit.): *Die Wirklichkeit der Medien. Eine Einführung in die Kommunikationswissenschaft.* (Opladen, 1994).

As was said before, and unlike mass communication, interpersonal communication is basically related to the physical presence of the communicating parties. *"The dominating concept of interpersonal communication is that it occurs when two or three people hold a face-to face interaction. In view of this circumstance, the immediate access of feedback is a given (reaction of the communicator with the others) since most of the senses (sight, hearing, feeling, tasting and smelling) can be used without any mechanical element (public system direction, telephone, television camera) separating the interlocutors"*[131].

Given the framework of interpersonal and mass communication concepts already described, John December analyses the controversy of communication via Internet. In his work *Units of Analysis for Internet Communication*[132] he deals with communication via Internet and computer transmitted mass communication. However, as far as computers are concerned, they are also used in other contexts. On the other hand, they technically differ according to the potential of use of other platforms such as radio receptors, television sets and telephones. For the characterization of these channels, two widespread concepts are often used: multimedia and interactivity.

Apart from other factors, the type of computer used will greatly differentiate communication via Internet. The multimedia concept describes these differences. Grob and Bensberg use the descriptive criteria of *mediatic* integration and *interactivity potential*[133] to account for it. Mediatic integration refers to the possibility of asynchronic -deferred in time- reproduction/representation of static (texts, graphs, etc) and dynamic (sound, animation) means. As examples they mention that Internet technology in theory enables video conferences, among other possibilities; however, access to this feature is not possible with just any machine. The computer should be equipped with adequate hardware and software technology to receive and send sound and video signals.

The second criterion employed by Grob and Bensberg, *interactivity*, is rather confusing because the authors fail to draw clear-cut lines between the concepts of interaction and interactivity.

When the new communication technologies are mentioned, their interactivity potential is often highlighted. In most of the cases, these qualities are meant to be highlighted as opposed to the limited possibilities of feedback available in classical mass media. In his book *Communication Technology: The New Media in Society*, Everett Rogers says that *"the differentiating feature of the new media is interactivity, which signals a fundamental change in the direction of the one-way, one-to-many communication flow of written and electronic media of the last century"*[134]. What Rogers really means by interactivity is a technological characteristic of the respective means, e.g. CD-ROM games or interactive television. The prevailing idea is the user's possibility of reaction after the action performed by the system or other user. Assuming the tele-spectator could remotely move from his TV

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[131] Gerald M. Miller and Mark Steinberg, *Between People. A New Analysis of Interpersonal Communication*. (Chicago, 1995).

[132] John December, "Units of Analysis for Internet Communication". *Journal of Computer Communication*. (Vol. 1, Nº 4).

[133] H. Lothar Grob and Frank Bensberg, "Multimedia". *Arbeitsbericht* (Nº.3. Begriffliche Abgrenzungen.1996).

[134] Everett M. Rogers, *Communication Technology. The New Media in Society*. (New York, 1986).

set the angle of a camera transmitting a soccer game, this reaction is only a simulation of a real reaction he may have. Each feedback is *predetermined* by a “service” of the media. For the user, only the formal possibilities of selection increase. The most popular computer games frequently stand out beyond their content (plot concept) and formal aspect (media integration) due to the lifelike simulation of cognitive system reactions. Therefore, programmers of these games resort to complex programming tools which include mathematical functions, variables and “if” and “when” type constructions for these purposes. Thus, according to the programming, a user’s action can lead to different types of feedback, as scheduled. Although this type of interactivity may bring about differentiated effects on who controls the game, the feedback generator program will never allow a conscious choice on the part of the user.

On the other hand, according to Rheingold[135], Internet users constitute virtual communities. For him the term community means *“group of people who share certain characteristics and who interact*”. On the other hand, the term virtual means *“only in essence or for its purpose*”; we can therefore assume that a virtual community *“is a group of individuals who share certain characteristics and interact solely in essence or for its purpose”*. In other words, Rheingold is categorical when he expresses that individuals who constitute a virtual community although they are mutually influenced “as if” they interacted, in fact fail to do so.

These points of view are not shared by Höflich who describes the interactivity concept not only as a characteristic of the environment but especially to feature interaction processes. The concept of interaction has been expressed before; however, it is worth bringing it back because the constraints derived from electronic media interposition in the interaction processes are still a source of controversy.

According to Höflich[136], interactivity is definitely a way of interaction. Somehow, he is taking the participation of other additional users for granted. In this sense, he replaces the notion of individual-machine interactivity for the concept of individual-machine-individual/s. *“The use of interactive media differs from other types of mediatic communication because unlike mass media or computer games, it excludes a mediatic satisfaction of communication needs when others do not participate”*. In connection with this aspect, Sheizaf Rafaeli[137], distinguishes between *interactive*, *quasi-interactive* and *non-interactive communication* sequences. The difference between them is rooted in whether if there is a conscious, thoughtful reference to one, none or multiple actions are produced during the action-reaction sequence.

As previously said due to its ambivalent meaning, the interactivity concept makes a generic characterization of communication via Internet difficult, since it is not possible to differentiate actions based on a cognitive process from those not subjected to it when the same term is employed for both cases. This difficulty is relevant when determining whether the Internet can be considered an informal channel of communication, besides being a formal one. Therefore, Goertz´s proposal is not to analyze the interactivity of the media (as

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[135] H. Rheingold, *The Virtual Community: Homesteading on the Electronic Frontier*. (Reading Mass. Addison Wesley. 1993).

[136] Joachim R. Höflich, “Technisch vermittelte interpersonale Kommunikation. Grundlage organisatorische Medienverwendung, Konstitution "elektronischer Gemeinschaften", (1996).

[137] Sheizaf Rafaeli, *Interactivity. From New Media to Communication*. In: Robert P. Hawkins,; John M. Wiemann, and Suzanne Pingree, (edit.): *Advancing Communication Science*. (Newbury Park. 1988).

a service offered by them) but the interactivity of use[138]. He establishes four measurement factors:

Possibilities of selection level
Possibilities of modification level
Size Magnitude of the offer of possibilities for selection and modification, and
Linearity / non-linearity degree

However, this researcher admits that this classification is adequate in a limited way to describe “interactive potential” of possible uses of Internet, regardless the real use.
From the social communication perspective, it is worth asking a basic question in connection with Internet: from the users’ perspective, are direct participants of the different steps of the communication process really other users or just machines in a broader sense? The difference is that for people, action and reaction are optional possibilities while this is not the case for machines. Users contextualize, explore, experiment, build. In this sense, considering the conditions of everyday human communication, cognitive systems are superior to any known information transmitting system[139].

Regarding the communication chain configuration, there is a sharp qualitative difference between the user’s possible access to a CGI database via a World Wide Web document (CGI: Common Gateway Interface; it enables the connection of additional programs to the Net information offer) compared to a search of information in newsgroups. In the first case, the type of feedback is predetermined while in the second one, it is open.
Based on these aspects, Morris and Ogan, define the Internet as *“a many-side mass medium, with a wide range of configurations of communication and where, compared to traditional models of communication, each configuration can change from ‘one to a few’ to ‘one to many’ [140]”*. In other words: the possibility of pre-determining the number of individuals (one, several or many) with whom simultaneous interaction will occur in real time (synchronic) or deferred time (asynchronic) makes the difference with other media or channel either formal or informal.
The Internet enables forms of text-based asynchronic communication (e-mail or newsgroups), text-based synchronic communication (Chats) as well as spoken synchronic communication with images (telephone and video conference). All these ways of technically transmitted interpersonal communication can be combined in the Net, solely depending on the platform (hardware) available to users.

Newsgroups gather a true community. One can promote oneself and participate actively by letting oneself known, expressing one’s capabilities before the rest and becoming a reference whose opinion may be sought in the future. This relationship resembles the face to face relationship of interpersonal communication.
There are newsgroups on practically any topic; many of them are even dedicated to rumor diffusion.

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[138] Benjamin N. Goertzel, *The Evolving Mind* (New York, Gordon and Breach. 1993).

[139] Gebhard Rusch, “Kommunikation und Verstehen”. In: Klaus Merten and Siegfried Schmidt, (edit.): *Die Wirklichkeit der Medien. Eine Einführung in die Kommunikationswissenschaft.* (Wiesbaden, 1994).

[140] Merill Morrisand Christine Ogan, “The Internet as Mass Medium”. *Journal of Computer-Mediated Communication*. (Vol. 1, Nº4 ,special insert in *Journal of Communication*, 1996).

The Internet provides us with an instrument that can be used as mass media, selective mass communication or individual mass communication either synchronically (telephone or television) or asynchronically (graphic media or traditional mail). It is an instrument which can be used as the link for institutionalized or formal communication or as an informal channel. A channel through which geographical distances are dissolved in a space without location and where there are two states: zero distance (within the net) and infinite distance (outside the net)[141].

As far as contents are concerned, it seems obvious that Internet is limitless. It allows for anything, from intimate communication through political campaigns, payment of commercial transactions, exchange of scientific information and opinion to –obviously- rumor generation and diffusion. In connection with these, according to the German reporter Gundolf Freyermuth, *"the Cyberspace has become the recreational center of paranoids and conspiracy theory maniacs".* Obviously, the progress of information techniques such as Internet ensures an unprecedented knowledge mobility, restoring the reign of information flexibility for any circumstance.

The more users with access to the Net, the more benefit for each user in particular. In this respect, the exchange of experiences and the diffusion of information or rumors can be incredibly huge within computer networks. Net researchers have determined that if there are more possibilities of finding answers to problems or questions, it is more likely for users to resort to this option, specially if what is being sought is answers to questions for which there is no official response.

1.2.3.1 Rumor in the Net

The Internet allows any kind of people in any walk of life to launch whatever he wishes to the cyberspace, the only limit being his imagination.

In this way, the Net has become the favorite means to spread all types of rumors on a planetary scale.

Today, nearly 80 million cybernauts worldwide who navigate through more than 15 million web pages are connected; therefore, it is easy to find information on any type of imaginable rumor, specially the so-called conspiracy rumors.

Diana Spencer's tragic death was followed by such information hunger that the authors of the "Conspiracies of all times" page, one of the typical pages dedicated to conspiracy rumors, were forced to release a newsgroup (alt.conspiracy.princess-diana) in order to debate and receive opinions on the different existing theories about the former princess of Wales' death.

A few days after the tragic accident and when all editors worldwide had reached a tacit agreement on neither acquiring nor circulating photos of the dying Diana, the pictures apparently taken by paparazzi were published on the Internet.

This not only shows the out of control nature of the web, but highlights the fact that the main danger is its speed, as far as the effect of rumors is concerned. The moment something takes place on the planet, the rest of the world can learn about it before TV or radio are able to react. As soon as the deaths of Diana Spencer and Mother Theresa were announced, the Internet was filled with dozens of obituary pages.

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[141] Manuel Castells, "The Rise of the Network Society". *The Information Age: Economy, Society and Culture*. (Vol.1. Cambridge, Blackwell. 1996).

Many companies are becoming aware of how vulnerable and dangerous the Net can be when non existent news event be spread. A favorite target are listed companies listed in the Stock Market. This has lead NASDAQ, the electronic US stock exchange, to develop and introduce a surveillance device on Internet to detect false information that could have been launched and spread to affect specific stock. The idea is to see what is being said in corporate newsgroups, and to detect untrue information on the main 4 thousand listed shares.
It is not surprising that in the near future the figure of "notary of the net" may appear, according to the report from America Newspaper Group (El Mercurio, Nov 29th, 1997), as a service that qualifies to for certify the reliability of a piece of information on the Internet. In fact, according to the news cable, there are companies that offer a reward for the identification of anonymous messages that fill the Internet with rumors affecting quotations of specific companies. The best known case involves an individual, Steve Pluvia, whose identification is worth 5 thousand dollars. He spreads untrue information about mergers and bankruptcies via Internet.
As we said before, any reason is good to spread rumors on the Internet; however, due to its global net nature, the favorite ones seem to be those linked to conspiracies.

Mass media usually deny the fact that they resort to the Internet to find a news supply. However, it is proved that most of them do it. Their pursue to be on the street before their competitors often lures radio and television stations and the press to resort to the WWW without verifying the truthfulness of the information.
This statement was confirmed by a survey conducted in 1985 at the School of Journalism, Columbia University, with 6,000 reporters and editors from 500 out of 2,000 magazines and 300 out of 1,815 newspapers published that year in that country.
According to the survey, 23% out of 751 answerers resort to the on-line services for their professional career at least once a day, 24%, at least once a week and 21% from time to time and only 9% claimed they resort to this service on rare occasions.
A vast majority (over 69%) use Internet to search for journalistic-oriented information. From this group, over a third resort to newsgroups, favorite place for those who spread and exchange rumors.

Research did not determine the treatment given by journalists to Internet's informal data; informal stands for data obtained from e-mail or newsgroups, as opposed to formal information published in institutional pages from companies, government and non-governmental offices and universities. *"The problem with these "sources" is that reporters cannot know for sure their real identity. The sixty year old teacher found by the journalist in the e-mail list or supporting data or opinion in a newsgroup may actually be a thirteen year old schoolboy. An apparently genuine e-mail may have been created through Fidonet or an Internet server of a third country installed for that purpose. It is very easy to do it, whether via Internet itself or via telephone access or electronic bulletin board. When forwarding, the address of the original sender may be removed and replaced by a false one"[142].*
According to Steven Ross, professor of Journalism at Columbia University, many stories based on e-mails end up being reproduced in the media with no verification whatsoever.

[142] Steven S. Ross, "Journalists' Use of On-Line Technology and Sources". In: Diane L. Bordenand Kerric Harvey, (edit.): *The Electronic Grapevine. Rumor, Reputation, and Reporting in the New On-Line Environment.* (New Jersey, Lawrence Erlbaum Associates Publishers. 1998).

He adds that it can be claimed that many journalists do not understand the existing fraud potential; many stories involve journalists who are actually supposed to be aware of it. There are stories written by IT columnists on related topics and many times for publications on computers. In this way, rumors find the ideal channel on the Internet, for example the one related to the flaws of Pentium processor from Intel company spread by Internet by the beginning of the 90´s.

Pierre Salinger, a renowned U.S. journalist and former press advisor to president Kennedy, shocked the world with his announcement at a conference to French officials that he possessed "irrefutable" evidence that a bomb had caused the TWA flight 800 tragic fall. Salinger said that he had obtained this information from a French Intelligence agent. After some time he was forced to admit that it came from a document available on Internet that it had been placed by an allegedly "leading researcher in aviation issues". His "irrefutable evidence" was actually nothing but a simple rumor.

1.3 Rumor as Noise

For Roland Barthes, rumor is a noise of voices deprived of the notions of truth and lies. What actually interests is its mere circulation[143].
The notion of noise is a concept that stems from the theory of information. In essence, it is anything within the channel different from what was placed by the communicator. It can be a stimulus competing from inside, like the hum of an alternate current in the frequency of a radio broadcast, the back printing that is visible through a thin page of a magazine or the daydreaming of a student during his classes. It can also be stimuli competing from outside, like the shocking headlines of a newspaper trying to catch the reader's attention, reading a book while listening to a news program or the murmur at the movies or a library. As discussed in the following chapters, an increase in redundancy can lessen the noise.
In a social system, in the context of normal interactions, the rumor is a noise because its nature is spontaneous, unexpected and disturbing. As noise distorts a transmission, rumor often distorts the reality of a fact characterized by a certain degree of ambiguity.
The formula of the theory of information in order to obtain the maximum transmission capacity despite noise is the following:

$$W \log_2 \frac{P + N}{N}$$

W being bandwidth, P transmission power and N noise. In other words, in order to approach maximum efficiency in a transmission with a certain level of noise, bandwidth or transmission power can be increased. In a social system of communications, bandwidth is represented by the number of channels (formal and/or informal), and the transmission power by the importance given to a topic by the audience. In this way, to limit the effect of rumors (noise), it may be possible to transmit information via the maximum number of channels or to increase the relative importance of the topic (for example, when news programs magnify a piece of news or increase the frequency of its broadcast diffusion).

Josiah Macy (Jr.), Lee S. Christie and R. Duncan Luce go beyond in their work on Noise Codification. They introduce the concept of *codification noise*[144]. This noise comes from

[143] Roland Barthes, *El Susurro del Lenguaje. Más Allá de la Palabra y la Escritura*. (Barcelona, Buenos Aires, México, Editorial Piados. 1994).

ambiguity. In Stanley Schachter and Harvey Burdick's terminology, ambiguity or codification noise translate as cognitive non-clarity. In their article *Field Experiment on rumor transmission and distortion*[145] (see second chapter), they tested the effect of *cognitive non-clarity* on information transmission in a natural group instead of a laboratory experimental group. They found that distortion derived from cognitive non-clarity is scarce, and that information or rumor transmission depend on the importance given to the topic.
In *Distortion of Information*, John R. Kirk and George D. Talbot[146] established that there are three types of noise in general human communication: *stretching distortion, fog distortion* and *mirage* or *illusion distortion*. They provide examples for each of them in a wide range of mass media and show the possible way of correction.
In the case of stretching distortion derived from, there is no information loss in the message. It is like the use of an anamorphic lens for cinemascope film projection. This lens captures stretched images but the screen projection lens corrects this effect. Something similar happens with credibility of communication: an individual used to lying is no problem: you recognize his language and you learn a simple and safe rule: add "no" to main verbs. The liar then becomes an oracle.
In fog distortion, information suffers a loss due to the lack of clarity. It is like a snapshot of a countryside landscape that captures neither the insects on the bush nor the real sunlight. The first because it is too small; the other because it is too bright. In communication, this loss can occur because of the different intellectual level of interlocutors; one possesses a more limited language and vocabulary than the other, or the level of intelligence is different among interacting individuals; the conceptualization of the message then differs.
Finally, the mirage distortion, "we can see what is not there". Kirk and Talbot say that far from having a loss of information in the message, there is extra and undesired information. It *should* actually be undesired but let's admit that there are many people in favor of "mirages" and "illusions". It should be undesired because it is likely to be wrongly interpreted as relevant information. False theories -as conspiracy theories- often result from mirage distortion "transferred" along the perception-conception continuum, from the first pole to the second one.

1.4 Rumor Distortion Process

One of the questions that caught Allport and Postman's attention was the development of rumors known as "serial or chain transmission", where rumors are successively reproduced and distorted along person to person transmission.
To show this effect, known as "Chinese whispers", music hall entertainers usually narrate the following story about change of guard in a quarter:
The captain to the officer in command:

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[144] Josiah Macy (h), Lee S. Christie and R. Duncan Luce, "Noise Codification in a Task-oriented Group". In Alfred G. Smith, *Comunicación y Cultura (2).* (Buenos Aires, Ediciones Nova Visión. 1977 in Spanish), page 189-201

[145] Stanley Schachter and Harvey Burdick, "A Field Experiment on Rumor Transmission and Distortion". In Alfred G. Smith, *Comunicación y Cultura (2).* (Buenos Aires, Ediciones Nova Visión. 1977 in Spanish), page 203-220

[146] John R. Kirk and George D. Talbot, "Information Distortion". In Alfred G. Smith, *Comunicación y Cultura (2).* (Buenos Aires, Ediciones Nova Visión. 1977 in Spanish), page 221-240

"As you know, tomorrow there will be a sun eclipse, something that is not usual. Take the troop to the maneuver field at five in the morning in their fatigues. They can watch the phenomenon and I will give the necessary explanations. If it rains there is nothing to see; in this case leave your men in the quarter".
The officer in command to the sergeant:
"Following the captain's instructions, tomorrow at five in the morning, there will be a sun eclipse in fatigues. The captain will give the necessary explanations at the field, something that is not usual. If it rains, there is nothing to see; in this case, the phenomenon will occur in the quarter".
The sergeant to the corporal:
"Following the captain's instructions, tomorrow morning at five, there will be an opening at the maneuver field: the troop will be in their fatigues. The captain will give the necessary explanations in the quarter on this strange phenomenon if it rained, which is something unusual".
The corporal to soldiers:
"Tomorrow at five, the captain will make the sun to eclipse in his fatigues with the necessary explanations at the maneuver field. If it happened to rain, the strange phenomenon would be in the quarter, which is unusual".
Soldiers to each other:
"Early morning tomorrow, at five, the sun in the maneuver field will make the captain eclipse in the quarter. If it happened to rain, this strange phenomenon would take place in our fatigues, which is unusual".
This humorous example is an illustration of the essential distortion phenomena attributed to rumor by Allport and Postman[147]: search of intelligibility in function of memorization, development of some relevant or significant details such as "eclipse" and influence of individuals involved in the interpretation (in this case, different socio-cultural levels). Rumor is not only distortion. The problem is the origin. The starting point of the rumor.
The last chapter discusses the process of distortion.

1.5 Ambiguity and Importance

As a conclusion of their studies, Allport and Postman developed their famous formula, according to which rumor is a function of ambiguity multiplied by its importance:

$R = f\,(A.I)$

In other words, the formula means that the quantity of circulating rumor will vary in connection with the importance of the topic for the affected individuals, multiplied by the ambiguity of the evidence regarding such topic. The relationship between importance and ambiguity is not an addition but a multiplication: importance or ambiguity being zero, there is no rumor[148].
Nobody in this latitude would be ready to spread a rumor of an African Chibuti village because nobody would be interested in it. If the event is not important, if it does not steer any emotion in the audience, there will be no rumor. According to Allport and Postman, a

[147] G.W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947), page 137-158

[148] G.W. Allport and Leo Postman, *op. cit.*

rumor is not launched at will (something refuted by most researchers). So, if the I factor is null, R is *null*.
On the other hand, ambiguity favors the appearance and spreading of rumors, i.e. the secret, the lack of official information bring about rumors which can get out of control. However, as shown years later by other authors, in times of crisis it is not enough to provide true information to avoid rumors. Since the very nature of a crisis, an unusual event, breaks the usual criteria of verisimilitude or inverisimilitude, this event frees imagination and re-activates traumatic memories and ancient ghosts (Durandin, 1960, Knopf, 1975, Koenig, 1985, Kapferer, 1987).

On July 20, 1944, after the unsuccessful attack against Hitler rumors about new attempts began to circulate as well as news reports on alleged riots in Germany followed by a cruel bloody repression. They were published in many countries. On July 31 of the same year, Times Magazine stated that Gestapo was arresting civil citizens massively, that Vienna's Gauleiter had fled, that 400 German officers had committed suicide, etc. This information was considered to come from neighboring countries, sometimes Switzerland, sometimes Sweden.
There had been attempts to kill Hitler had been reported before, but since they had not been so well known were not son well known they had not arisen so many rumors. However, the July 20 attack was immediately known, although the details were ignored, it set the popular imagination free, also reflected in the foreign press. Another fact that broke the limit between verisimilitude/ inverisimilitude was the announcement of "glasnost" (transparency) made by Gorbachov in the Soviet Union in 1985. He thought that this policy would end with all types of rumors circulating countrywide since the beginning of reforms ("Perestroika"). However, the Soviet population, used to decades of state secrecy, did not only believed in this strange fact and rumors multiplied because the revelation of events previously held secret brought about unconfirmed reports about non existent new secrets.

1.6 Rumor Credibility

Rumor is interesting because it ranges between what is believable and what is not. According to Eliseo Veron, credibility is associated to the anonymous nature of the source. For him, rumor is *"the voice that speaks without responsibility because there is no evidence. Its conditional, anonymous tone, that nobody proclaims under his own name, is passed on as collective word. When it involves someone it requires correction. There is a game between anonymity and truth. When the speaker passes a rumor on he does not assume responsibility for it"*[149].

For diffusion of a rumor to prosper, its content not only should seem believable but also the speaker should be trustworthy.
Society does not leave questions unanswered and is not interested in answers to non formulated questions. When the question exists and the answer is deferred, rumor takes its place. When there is no question, rumor does not prosper. As with myths, it is not possible to create a rumor from scratch. There are no lab rumors. In that sense, according

[149] Eliseo Verón "Cuadros de Costumbres. La Paradoja del Rumor". in *Página 30* (Argentine Magazine). (Year 7 - Nº 79. February 1997)

to sociologist and writer Beatriz Sarlo[150], rumor is a *fictional truth* or *true fiction*. It is a fictional truth because it is a hypothesis rather than established facts (when facts are established, rumor becomes news). It is true fiction because, regardless of its truthfulness, it should comply with adjust to some rules: if the rumor is intended to circulate and thrive, it should contain at least one trace of likelihood.
It is hard for something totally fantastic to become a rumor because it fades away long time before it starts its oral reproduction circuit. This does not mean that rumor needs to be *completely credible*. According to Sarlo, should this be the case, its shape would not be that of a rumor, which always contains something exaggerated, weird, unheard of, dangerous, hidden and hard to verify. In the same way that not any story is mythical, not just any story can become a rumor.

According to Kapferer[151], the individuals surprising intuitive ability to relate with rumors is given by the everyday nature of this phenomenon. Within this framework, we can also say that rumor is strongly rooted in its oral nature which links it to specific social environments, where it is transmitted from mouth to ear. This face to face communication is what confers credibility on a rumor. Since the truthfulness of its content is probable but not certain, for rumors to be credible, they are frequently told as confirmation or refutation of a reliable source.

The source is not always “the one who is talking”; this term is reserved to the one who expresses and defends his opinion, even if the message is transmitted or repeated by another person. In the case of rumor, the source is attributed. In this sense the message can be attributed to all types of sources: people individualized by name and known for their historic, political, scientific, artistic, hierarchical role; people whose names are mentioned or not, but who hold a position in a well known newspaper, political party, religious community or any other organization. It can also involve people without name and frequently individualized to a limited degree, whose only expressed identification is the occupation (engineer, doctor, etc.); reference groups evoked by a label (e.g. socialists), or sociological groups (e.g. law students), or even randomly chosen samples, for example: “75% of the people surveyed said that ...”.
According to studies conducted by Hovland and Weiss[152], the source is considered trustworthy when it is judged to be *competent* and *reliable*. In 1982, Gremain de Montmollin determined the distinction between *specific competence* in a specific field and *generalized competence*[153]. For this researcher, the competence assessment that the recipient makes about an expert on a certain field can be generalized to other fields of knowledge: he showed that a message about the dangers involved in the abusive use of aspirin attributed to a doctor (specific competence) had a uniform effect on randomly chosen individuals in the street. The idea that attributed competence can be generalized is

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150 Beatriz Sarlo, “Cuadros de Costumbres. La Paradoja del Rumor”. in *Página 30*. (Argentine Magazine). (Year 7 - Nº 79. February 1997)

151 Jean Noël Kapferer, *Rumores: el Medio de Difusión más Antiguo del Mundo* (Barcelona, Plaza y Janes Editores, 1989)

152 C. I. Hovland and W. Weiss, “The Influence of Source Credibility on Communication Effectiveness”, *Public Opinion Quarterly* (Nº 15, 1951), pages 635-650

153 Germain de Montmollin, “The Change of Attitude”, in S. Moscovici, *Psicología Social I: Influencia y Cambio de Actitudes/ Individuos y Grupos* (Buenos Aires, Paidos, 1984 in Spanish), page 124-125

related to the notion of prestige -widely used but as many other common notions, hard to define and wrongly analyzed (Montmollin, 1984). Regardless of the reason of its *prestige* (knowledge, social status, celebrity) the source can be considered competent by the recipient regarding its views; therefore, it can make listeners adopt it.
As shown by several research papers (Hovland and Weiss, 1951; Aronson and Golden, 1962; Eagly, Wood and Chaiken, 1978) every message has a higher impact when it comes from a source considered as superior in knowledge, education, intelligence, professional success, even when the recipient only counts with little information or parameters to judge this competence. However, according to Montmollin, this conclusion is to be taken as a relative one, since the effect of competence depends of the recipient's uncertainty about the problem in question; if his position is strong, he will not accept the rumor even if he considers the source to be a competent one. Likewise, the effect depends on the recipient's motivation: if he looks for the most valid opinion about a problem, competence becomes a relevant criterion.

The trust inspired by the source is another decisive factor: people, although aware of the fact that the rumor transmitter "knows" the truth, can doubt whether what is said is actually the truth. The recipient only deposits his trust if he views the source as objective, disinterested and not intending to manipulate or deceive. The source is perceived as objective if it seems not to willingly privilege one of the aspects of the problem at the expense of the other and if it is not suspected to raise a rumor to benefit himself or benefit or damage a third party. In 1953, Hovland[154] compared the effect of a message favoring the reduction of customs duties; on the one hand it was attributed to a university professor specialized in economy, and on the other to the director of an important import-export company. The answers showed that the professor's version was considered *disinterested and more honest*, although neither source convinced the individuals surveyed.
The effect of will of the source to persuade others seems more subtle. People do not like attempts or intention to influence them; when someone suspects that the source or the rumor transmitter is intended to persuade them, they are reluctant by reaction to what is perceived as an attempt against their freedom of opinion[155].

Most rumors start as a report of a perception experience that someone had of an event which he considers interesting and important enough to be passed on to others. Once this key topic has been accepted, there is a tendency to distort the subsequent news or events in order to make them consistent in connection with the key topic. However, Davis´ studies in organizations show that this distortion does not seem to occur in companies. He concludes that *"in normal business situations, between 75 and 95 per cent of rumor-based information is correct"*[156].
In general, people tend to think that rumor is less accurate than it really is because its errors tend to be more dramatic and consequently, they are more embedded in our memory rather than in the daily accurate rumors: *"In a normal job situation, over 80% of rumor-based information is accurate. While daily precision may be positive, people believe that rumor is less precise because the times when it is incorrect are more dramatic. The*

[154] C. I. Hovland et al, *Communication and persuasion* (New Haven , Conn., USA, Yale University Press, 1953)

[155] J. W. Brehm, *A Theory of Psychological Reactance* (New York, Academic Press, 1966)

[156] Keith Davis, "Communication Within Management", in William A. Nielander and Max O. Richards, *Management.* (Cincinnati, 1969)

details of a certain communication can be 90% correct, but the remaining 10% is often the most important part of the message. Messages of the rumor usually lack details, so they are likely to be misunderstood; rumor generally carries truth, but it seldom carries all the truth"[157]*.*

Another interesting conclusion drawn by Davis is that around 80% of the information transmitted via rumors is individual-oriented, while 20% is company-oriented[158].

1.7 Conclusion

The first definitions described rumor as uncontrolled news, usually orally passed on among different people and consisting of repetition of something that actually occurred or not (Knapp, 1944).

As time went by and after the studies conducted by Allport and Postman (1947), Caplow (1947), Daugherty (1958), Wright (1960), De Fleur (1962), Gluckman (1963), Buckner (1965), Shibutani (1966), Knopf (1975), Rosnow (1976), Kapferer (1993), Durandin (1993) and others, rumor has also been approached by sociology and considered a social construct that uses both informal channels (interpersonal communication) and formal channels (mass media).

Despite the authors mentioned and unlike other objects of research of social sciences, rumors have been little or not investigated.

All researchers agree that rumors fill a communication void, specially when an atmosphere of uncertainty prevails, and their most important feature is distortion along the transmission chain.

According Allport and Postman (1947), the amount of circulating rumor will vary depending on the importance given by individuals, multiplied by the ambiguity of the message evidence.

Origin, content, frequency, diffusion and transmission and truthfulness are essential for the analysis of rumor.

According to the psychological model, rumors are originated in the individuals' needs, impulses and interests and they derived from emotions. Their purpose, according to this school is to relieve feelings of guilt, anxiety, fear, wrath, resentment or hostility. An important factor for rumor generation can be found in the personality features of those who initiate or spread them.

Moods, opinions and prejudices of participants sharply influence the level of rumor receptivity.

The psychological model states that intentional forgetfulness (leveling) or exaggeration (sharpening) of details connected with the rumor is the essential reason for rumor distortion.

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[157] Jitendra Mishra, "The Management of False Rumors", published by *International Personnel Management Association* (USA, 1990).

[157]Keith Davis, "Grapevine: Communication Among Lower and Middle Managers", *Personal Journal*. (April, 1969)

[158]Keith Davis, "Grapevine: Communication Among Lower and Middle Managers", *Personal Journal*. (April, 1969)

On the other hand, Jung (1916) expresses that the more the excitement derived from a topic, the greater the number of individuals involved in the transmission chain.

The sociological model is based on a functionalist approach and considers rumor an essential social phenomenon. Tamotsu Shibutani is the main supporter of this trend initiated by 1960.
Sociology refers to rumor as a collective transaction where there is division of labor.
As in the psychological model, the functionalist model assumes a high level of ambiguity as a prerequisite for rumor generation. Thus, the problematic nature of the situation (not of the individual) is the center of the social analysis of this phenomenon.

When the function of formal channels of communication is interrupted or is inadequate, *“improvised news”* appear, i.e. rumors start to function as such.
For Shibutani, rumor always appears when the fact that provides the foundation for the story is unusual, important, the public is highly interested and the supply-demand ratio in connection with information is unsatisfactory.
When rumor is intentional and aims at manipulation, we speak of disinformation. This is in itself a social dysfunction, since what is being sought is alteration or destabilization of the social system or part of the system, with a specific purposes.

From the point of view of its formal analysis, rumor is a “fictional true” or a “true fiction”. In the first case because it is a hypothesis and not a fact. In the second case because, regardless of its truthfulness, it needs verisimilitude facets to prosper (Sarlo, 1997).
Koenig, Kapferer and Rowan try to typify rumor. Koenig´s classification is by content. According to Kapferer, this method is inadequate because it is tied to symbolic loads conferred by different cultures, environments or regions at a given moment. His classification is referred to the genesis and source of rumor. For him, the source of the story can be a fact, a detail or fantasy of individuals, while genesis can be spontaneous or provoked generation. Rowan’s analysis starts in the motivation of the one who generates or contributes to rumor diffusion. He establishes four categories: rumors based on the desire or dream fulfilled, those based on anxieties or ghosts, aggressive rumors and deferral rumors.

The difference between rumor and gossip is that from the point of view of content and in general terms, rumor is about facts and gossip is about absent people. Gossip is limited to interpersonal communication and rumor uses both informal and formal channels of communication. According to Gluckman (1963), gossip is exclusive of groups. Gossip can originate a rumor, and rumors can give rise to gossip; but they are just two faces of the same coin.
The analysis of channels of communication involved in rumor diffusion show that these channels can be formal or informal. The first have a limited participation: diffusion of the phenomenon. Its greater influence is given by the fact that rumors are born when they do not work or they have a restricted function. They also have an important role in the rumor conclusion, although it depends on the credibility of the media. According to Peterson and Gist (1951), rumor is a type of public opinion; therefore they include formal channels as diffusion means. This is shared by Davison (1962) when he says that the role of mass media is important as rumor channels, specially regarding influence of opinion leaders and opinion transmitters, who continue the diffusion through the informal media.

Informal channels are the classical rumor transmitters. They are based on individuals’ interaction (Hollander, 1967; Goertz, 1995) and basically depend on the mutual attraction

and influence among them (Schachter, 1951; Marshall, 1951; Mandelbaum, 1952). An important aspect is the evaluation performed by people on the credibility of the message (Sarlo, 1997; Veron, 1997) and interlocutor (Kapferer, 1985).

The Internet is a fascinating laboratory for the study of rumor dissemination. It is a channel which is formal as well as informal. It is formal because it responds to an institutionalized medium labeled as “mass media” through specific technology (Maletzke, 1992; Morris and Ogan, 1995). It is informal because thanks to the technological possibilities of interactivity, whether synchronic (Chats) or asynchronic (newsgroups) and “e-mail”, the Internet has the appearance of an interpersonal communication channel (Rogers, 1986; Höflich, 1996).
Technically speaking, it is the only medium that links any point of the planet at any time within a network of nodes involving around 80 million users. Its growth is exponential and much faster than any other, even cable TV: it is the relatively fastest growing medium.
Chats and newsgroups associated to e-mail allow “one to one”, “one to many” and “many to many” communications; anonymity is possible thus encouraging rumor creation and diffusion. In turn, newsgroups imply the voluntary access of people interested in the topic. There is neither responsibility on the part of the individual to enter or leave the discussion nor commitment for quality contribution. Therefore, newsgroup communities linked by shared interests are the most fertile ground for rumor procreation and diffusion. If someone enters a newsgroup dealing with UFOs, Lady Di´s death or the TWA 800 flight fall, he is willing to speculate. This speculation is fascinating in itself because the nature of rumors resides in the fact that they are not totally false nor true either.
Due to Internet’s nature of global medium, conspiracy theories are classical among the rumors spread on the Net. They are discussed in the last part of this work.
The highly dynamical, non-linear, complex and recurrent system of rumors via Internet generates many different variables in this form of communication -more than any other media- in a surprisingly short time. The simultaneous nature of the triggering fact and the subsequent rumor discourse is one of the outstanding features of this phenomenon on the Internet. Also this immensely attractive feature determines that other mass media often resort to the Internet to obtain information, even when they overlook the high risk in connection with the reliability and truthfulness of the data used.
As expressed by the French philosopher Jean Baudrillard, *information has crossed the barrier of truth to evolve in the cyberspace of what is neither true nor false, because everything is based on instant credibility.*
Somebody launches a piece of information. It is believable as long as it is not refuted. Unless there is a favorable accident, it will never be refuted in real time; therefore, it will keep its credibility. Even if it is refuted, it will never be absolutely false because it has been credible. According to Baudrillard, unlike truth, credibility has no limits; it is not refutable because it is virtual. We are immersed within a sort of fractal truth: a fractal object does not have one, two or three dimensions (in integer numbers) but 1.2 or 2.3 dimensions; likewise, an event is not necessarily true or false, but rather ranges between 1.2 or 2.3 octaves of truthfulness. The space between truth and falsity is no longer a relational space but a space of random distribution.

Second Part: From Field Experiment to the Internet. Analysis of Four Cases

"Ever since men stopped believing in God,
It is not that they believe in nothing,
They believe in everything".
Gilbert Keith Chesterton

"With the speed of lightning
News has arrived,
Who is to say, only time will tell
If in the future it arrives with the bolt itself".
Lope de Vega

2 Analysis of Four Cases

Case analysis of rumors is a complex task, since its volatile nature does not leave traces for further reconstruction neither of its content nor of its diffusion.
Four cases were selected for this chapter: the first one is about a field experiment conducted by two researchers from Minnesota University in the early 60´s. In our opinion, the analysis of its results has to include certain reservations because, given the close environment where the rumor was introduced (a girls' school) and its limited duration (one day), the conclusions cannot be projected to rumors at a larger scale.
The second case (P&G) is a classic in the field of rumor and one of the few well-documented cases. Its magnitude in United States was basically due to the fact that it was about a great U.S. company and linked to a topic that affects religious communities in particular.
The remaining two cases are somehow recent (Lady Di´s death and the TWA flight explosion); their analysis was based on the material published in newsgroups and pages on the Internet.

2.1 Field Experiment conducted by Stanley Schachter and Harvey Burdick

As we have seen before, rumor is characterized as an unreliable and frequently distorted source of information that is quickly and mysteriously spread among almost all reachable members of a population. The concepts of distortion and exaggeration as features of this type of communication come from generalizing findings in perception and memory studies, where a serial reproduction technique was used. Due to the small number of studies on rumor diffusion, there is relatively little printed documentation supporting the preconception that diffusion is quick and widespread, but for a number of dramatic anecdotes.

However, the results of a laboratory study conducted by Schachter and Burdick[159] in the 60´s seem to contradict the before mentioned concept of rumor.
The first part of the present work deals with the attempt to standardize Allport and Postman's rumor diffusion conditions: their basic *"law of rumor"* is that "*the amount of rumor in circulation will be dependant on the importance of the subject to the individuals concerned times the ambiguity of the evidence pertaining to the topic at issue*"[160].
The "cognitive unclarity principle" stated by Festinger, Cartwright and others[161]shows a similar position. "*Rumors will tend to appear in situations where cognitive regions specially relevant for immediate behavior are mostly structured".* Both positions agree to identify cognitive unclarity or ambiguity, and importance as key determining factors for rumor origin

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[159] Stanley Schachter and Harvey Burdick, "A Field experiment on Rumor Transmission and Distortion". In Alfred G. Smith, *Comunicación y Cultura (2).* (Buenos Aires, Ediciones Nova Visión. 1977. In Spanish), page 203-220

[160] G.W. Allport and Leo Postman, *The Psychology of Rumor* (New York, Henry Holt, 1947),page 15

[161] L. Festinger, D. Cartwright et al, "A Study of Rumor: Its Origin and Spread", *Human Relations* (vol 1, 1948), pages 464-85.

and diffusion. The last position is somehow more specific as to the treatment of the variable of "*importance*" in relating it to key areas relevant to immediate behavior. This is the sense we will attribute to the term.
It is worth explaining something that is undoubtedly implicit in both positions, i.e., the cognitive unclarity state of an important problem is shared by all members of the population in question, or most of them.
In social communication there is a two-way exchange between two or more individuals; in addition, part of the content of the conversation is re-transmitted. According to Schachter and Burdick, the type of communication called "rumor" is characterized by a chain communication pattern[162] (as will be seen later, the concept of chain transmission is too constraining). A transmits something to B, B to C and so on. In this type of pattern, holding information seems to create a driving force that leads to continue re-transmitting it. Assuming that a situation likely to bring about such impulse to communicate contains cognitive unclarity, it seems clear that these conditions should be present in all group members or most of them for the rumor to be passed on. The chain communication pattern would otherwise be interrupted and rumor diffusion would be scarce, unless rumormongers were specially persistent.

The study conducted by Schachter and Burdick is a field experiment to test some ideas connected to determining factors in rumor diffusion. A situation bearing cognitive unclarity regarding an important issue was manipulated and rumors related to that issue were systematically implanted.

2.1.1 The Method

The experiment design consisted of three experimental conditions:
a) The "cognitive unclarity-rumor" condition (CU-R): cognitive unclarity was manipulated and rumor was implanted.
b) "Cognitive unclarity" condition (CU): cognitive unclarity was manipulated and no rumor was implanted.
c) "Rumor" condition (R): a rumor was implanted but no unclarity condition was created.

The study involved 96 girls from six courses at a school belonging to Minnesota University. Two courses were assigned to each experiment design condition, so that each pair was integrated by older students and younger ones.

To produce cognitive unclarity, on the day of the study, between 8:25 and 8:35, the school headmistress went to four different classrooms. She stood up before the students and pointing at one of them, she announced: "*Miss K, take your coat and come with me, please. You'll be absent for the rest of the day*". The headmistress and the students left the class.
This was an unprecedented occurrence for the students.
To make sure that the issue was kept secret, the school staff had been instructed to answer "we know nothing about it", when asked about the event.
The students who left the classrooms had been selected on the grounds of their sociometric status and academic and disciplinary performance. They were at the same

[162] Stanley Schachter and Harvey Burdick, *op. cit.*

level regarding these criteria. They were selected so that their grades and sociometric choices received from their mates were between 50 and 70% on average. In addition, none had disciplinary records. Therefore, these girls were average representatives of their classes, reasonably popular and with good grades. They knew nothing about the study until they were asked to leave the classroom.

The manipulation was successful in producing the desired variables. As part of the standard data collection procedure, all teachers had been instructed to keep a record of all the questions they were asked regarding the manipulation. They were asked to make notes about who spoke with them, when and the content of the questions or observations.
In each of the four classes where the headmistress had selected a student there were 62 girls. The teachers recorded 198 questions. Besides, one teacher who felt harassed because she was unable to cover the students' curiosity, reported that "*all the classroom asked me what had happened*" and another reported that "*half the class asked questions*".

Virtually all the students in the courses affected asked questions to one or more teachers, and most of the questions went like this: "*What happened with K?*" "*Why did the headmistress take K from the classroom?*" "*What is going on?*", and the like.
Given the nature of the questions, in most cases derived from curiosity and perplexity and with the purpose of getting information, Schachter and Burdick assumed that the manipulation actually produced cognitive unclarity shared by all -or most of- the girls involved in the experiment.

The rumor was implanted in and through two girls from each of the four different courses. Two of these courses were part of the four courses where cognitive unclarity had been created; the remaining two were the courses where there had been no manipulation at all. The sociometric, academic and disciplinary level of the eight girls used to implant the rumor was similar.

One or two days before the study was conducted, several teachers had arranged interviews with each of the students in question at 8:15 in the morning of the day fixed for the study. The purpose of these interviews was to talk about their progress, the syllabus for the next year, etc. It was a regular procedure. Each interview followed the same pattern: after six or seven minutes of talking about the alleged purpose of the interview, and immediately before concluding it, each teacher said: "*By the way, some exams are missing from the office. Do you know something about it?*" As this was untrue, all the girls said they did not know anything. The interview was scheduled in such a way that the girls returned to their classrooms before the headmistress visited them.
The rumor so implanted was intentionally selected so that it did not constitute an immediate explanation for the cognitive unclarity manipulation. However, it could easily be related to the morning events as tentative explanation. It was considered that asking the teachers to implant the rumor instead of a group of students was preferable, since the second option would imply the difficult task for the students of keeping regular behavior all day long. It was reasonably assumed that a rumor coming from a person with authority -a teacher- would restrain the type of speculation that could bring about new rumors.

Data was collected via the following methods:
1) Sociometric data: three weeks before the study was conducted all the participating girls answered a sociometric questionnaire. The school was planning a school fair and the students were supposed to work together on the shows, exhibitions, etc. This questionnaire was related to this situation and was presented like this: "*As you know, we*

expect to schedule the school fair at the beginning of the fall. We would like you to work with the mate you enjoy working with. Please, give us the names of your two closest friends for us to arrange the combinations ".
2) The teachers' comments: they all kept a record of the comments received in connection with the manipulation.
3) Standardized interviews: at 2 p.m., by the end of the school day, a group of 20 interviewers went to the school dining room to interview all the girls involved in the study. Interviews were scheduled so that the whole course was interviewed at the same time during dinnertime, thus avoiding communication related to the purpose of the interview. Everything was planned to prevent communication between the courses.
The interview contained a structured questionnaire and open questions; it was designed to obtain information related to what the girls had heard about the situation created by the cognitive unclarity manipulation, who they had talked to, whether they had heard the rumor implanted, who the source was, who they had passed it on, and how much time they had devoted to speaking about it.

By the end of the day, and after all the girls had been interviewed, a general meeting with all the courses involved was held. All the students were given a detailed and complete explanation of the study. The four girls who had been taken out from their classrooms and had spent the day with the headmistress in the campus participated in the meeting and were the heroine for the subsequent two days.

2.1.2 Results

2.1.2.1 Knowledge of the rumor and of the cognitive unclarity manipulation

The following chart shows the data connected to the percentage of girls who said they had heard of the rumor and the percentage of girls who said they knew that the headmistress had asked some girls to leave the classroom. This chart and several of the following ones show the corresponding data for each of the classrooms individually taken and for the two classrooms in each condition combined.

Knowledge of the rumor (R) and of the cognitive unclarity (CU) manipulation

Condition	No.	% CU manipulation awareness	% rumor awareness
CU-R1	18	100	100
CU-R2	15	100	100
CU-R1 + CU-R2	33	100	100
CU1	18	94	100
CU2	11	100	100
CU1 + CU2	29	97	100

R1	18	94	94
R2	16	100	100
R1 + R2	34	97	100

The CU-R1 represents one of the two classrooms of CU-R condition; CU-R2 represents the other classroom in the same condition and so on. The symbol CU-R1 + CU-R2 represents the two classrooms of that condition, combined. The chart clearly shows that practically all the girls had heard of the rumor implanted. Only one out of 96 declared she had not heard of the rumor. As far as having heard of the rumor is concerned, there are no differences between the conditions. Similarly, almost all the girls, even those in R condition, knew that some of the girls had been asked to leave the classroom. Only two girls said they did not know about it. Eighty five % of the interviewed girls related the rumor to the manipulation.

It is obvious that communication was meaningful not only in the classrooms but also among them. All CU girls had heard of the rumor. Almost all R girls knew that the headmistress had taken some of the girls out of other classrooms.
The fact that the rumor was been widely known in CU-R and CU conditions boils down both conditions to only one, i.e. to a situation of cognitive unclarity regarding an important issue, and a widely spread rumor.
The R condition is again characterized as a cognitive unclarity estate in connection with an unimportant issue. The fact is that although all the girls in that condition knew that the headmistress had taken some girls out from other classrooms for some mysterious reason, they had no sociometric connections with those students. Their faces were familiar, but they had no connection with those girls. Even though the manipulation allowed for the possibility of real changes in the relationship of the girls who left the classrooms and their immediate mates, this situation did not occur in girls of R condition.

Several data sources supported this new characterization of the R condition. There had been previous inferences about creating a cognitive unclear situation as from the questions formulated to the teachers. From the number of these questions it was possible to extract tentative inferences as to the “importance” variable. Virtually all individuals from all conditions knew of the cognitive unclarity manipulation. It is obvious that only the girls worried about the event would try to obtain information from their teachers. Teachers reported over 200 questions from the 62 CU-R girls, whereas only one question from the 34 R condition girls.

The time the girls devoted to speculating about the manipulation and talking about it may be considered an indicator of the importance of the event. In the interviews, after expressing they knew about the manipulation and having talked about it, the girls were asked: “*Can you tell us how much time did you speak about it? Try to be as accurate as possible*”.
CU-R and CU students responded that they had dedicated almost one hour and forty minutes; the girls from R condition, twenty. It could be argued that not only was the topic unimportant for R condition; the number of questions asked to the teachers and the time devoted to the topic showed that there was less cognitive unclarity. This could be the case if girls from R condition: a) were more prone to relate the rumor to the manipulation and believe that their mates had actually taken the exams; or b) had another explanation generally accepted and credited for manipulation. However, data reveal that there were no differences between the conditions to the extent that the rumor was related to the

manipulation or the level the rumor was believed to conclusively explain conclusively why the students were asked to leave the classroom. Moreover, most individuals from R condition expressed that they completely ignored why the students had been taken from the classrooms.

According to the authors, attention should be paid to the last piece of data, i.e. time devoted to speculation: one hour and forty minutes for CU-R and CU students and 20 minutes for R students. We should consider this in the light of the fact that R condition girls learnt about the cognitive unclarity manipulation episodes later than the girls from other conditions; consequently, they had less time for comments and questions to their teachers. However, according to the interviews, all R condition girls had learnt about the episode by the 10:15 break. As before this time the only chance of speaking freely with each other and with their teachers was during the five minute break between classes, it is clear that this factor is not enough to explain the important differences in the conditions.

The interview was constructed in such a way that the first question connected with the cognitive unclarity manipulation was a recall question and the following were recognition questions. After some warm-up questions the girls were asked: "*In most of the schools everything is similar from one day to another, but sometimes something extraordinary happens. Would you say that something unusual happened today?*" If the girl did not mention the experimental manipulation in her response, she was asked: "*Some of the girls we talked to said that the headmistress asked some girls out of the classroom. Did you hear about it? What did you hear about it?*"
The cognitive unclarity was supposed to be more evident and important for the students who mentioned it when responding to the recall question (*did something unusual happen?*) than for those who first mentioned it in the recognition question (*did you hear about it?*). The episode was mentioned in response to a recall question by 93 % of CU-R condition girls, 76 % of CU condition and only 26 % of the R condition.
These tests showed that the three conditions were characterized by an equal level of cognitive unclarity. The episode was equally mysterious for all the students. However, the problem in question lacked importance for R condition girls and was very important for CU-R and CU conditions.

2.1.2.2 Transmission of the implanted rumor

According to Schachter and Burdick, the driving force to pass on a rumor varies with the importance given to the problem, which carries ambiguity[163]. They showed that there was more transmission and comments on the rumor in CU-R and CU conditions than in R condition.
The information contained in the following chart was obtained from the girls' answers to the questions about knowledge and source of the rumor and whom they had passed it on. The figures transcribed here correspond to the average for each classroom and condition and the number of different girls to whom the rumor was transmitted.
The average of rumor transmission in CU-R and CU conditions more than doubled the average of R condition transmissions. The differences between CU-R and R are significant. No significant differences are recorded between CU-R and CU.

[163] Stanley Schachter and Harvey Burdick, *op. Cit*

Average number of individuals with whom conversations about the rumor were held.

Conditions	Number.	Average number of girls who heard the rumor.
CU-R1	16	3.19
CU-R2	13	2.46
CU-R1 + CU-R2	29	2.86
CU1	18	2.22
CU2	11	2.36
CU1 + CU2	29	2.28
R1	16	1.38
R2	14	0.79
R1 + R2	30	1.10

Rumor transmission was multiplied in classrooms with CU-R and CU conditions and relatively limited in those of R condition. 78 % of the girls started one or more communications connected with the rumor in CU-R and CU conditions, while 40 % from R condition did. Since all students heard of the rumor, it seems that their knowledge drove them to communicate and comment it more intensively when the related problem was important than when it was not.
However, Schachter and Burdick suggest that the dramatic nature of manipulation has probably brought about surprise and excitement, as well as a condition of cognitive unclarity.
It would seem reasonable that those factors acted with more strength in girls who witnessed the event than in those who had heard of it but were not present. It is therefore possible that CU-R and CU conditions differ from R not only regarding the importance of the event but the resulting effects of having witnessed the manipulation.

The importance of the problem is also expected to vary within each classroom and the condition. It could have been very important for some girls and less important for others. A criterion to distinguish girls in this sense was the nature of the relationship with the girls asked to leave the classroom. The episode is likely to be more important for closer friends than for those who are not, since friends are expected to communicate the rumor with more intensity.
Since almost all sociometric elections were carried out within the classroom, the grounds for the following means are the four classrooms in CU-R and CU conditions. The girls who gave one of their votes to the mate who left the class in the sociometric test held communications on the rumor with 3.10 different girls. The ones who did not choose them in the sociometric election reported only 2.00 communications of the rumor.

2.1.2.3 Origin of new rumors

The authors assume that the same factors that promoted the diffusion of the implanted rumor encouraged the type of speculation and hypotheses that results in new rumors. Thus, they anticipated that the diversity and spread of new rumors is greater where the problem is more important. The following chart shows the evidence.

Column 3 of the next chart shows the percentage of girls in each of the classrooms who expressed they had commented a rumor different from the original one and related it to the cognitive unclarity manipulation. 70 % of the girls in CU-R and CU conditions reported they had passed on other rumors; 15 in R condition did so too. The difference between CU-R / CU and R conditions is meaningful; however, between CU-R and CU it is not, which shows that the more important the problem, the greater the circulation of new rumors.

Prevalence and diversity of new rumors

Condition	Number	% of girls who informed about new rumors	Number of different rumors
CU-R1	18	72.2	16
CU-R2	15	80.0	15
CU-R1 + CU-R2	33	75.8	-
CU1	18	72.2	14
CU2	11	54.6	-
CU1 + CU2	29	65.5	-
R1	18	5.6	1
R2	16	25.0	2
R1 + R2	34	14.7	-

In the two conditions of high importance, circulation of rumors different from the original one was greater and new rumors were more diverse. Column 4 lists out the number of different outstanding rumors in each of the classes. In CU-R and CU conditions an average of 12 different rumors per class was reported, while in the two classes of R condition, only 1.5 different rumors per class was reported.

It could be anticipated that “close friends” would tend to circulate more new rumors compared to the girls who did not choose the students who left the classroom in the sociometric election. Although friends passed on an average of 1.55 new rumors and those who were not friends, 1.32, a slightly lower number of friends passed on these new rumors. 78 % of the friends reported that they had passed on rumors different from the implanted one, as well as 74 % of the girls who were not friends. None of these differences is significant.
However, there is a difference in the type of rumor said to be commented by both groups. Researchers categorized the various outstanding rumors in virtue of how optimist or pessimist the explanation for leaving the classroom was. Some of these rumors were

favorable to the girl, for example: "*She is beautiful and she was invited to have tea at the teacher's home.*" Others were unfavorable: "*She is being punished because she went to a wild party*". There were neutral rumors such as: "*She has to go to a lecture*".
The following chart shows the percentages of each type of rumor passed on by friends and not friends. Out of the total number of rumors passed on by friends, 52 % are favorable and 29 % unfavorable.

Friendship and new rumors

Group	**#**	**Nº of times new rumors were transmitted**	**% of new rumors which were**		
			Favorable	Neutral	Unfavorable
Friends	31	48	52	19	29
Not friends	31	41	34	10	56

Those who are not friends passed on 34 % of favorable rumors and 56 % of unfavorable ones. Among friends who passed on rumors, 76.2 transmitted either one or more favorable rumors; of rumor transmitters who are not friends, 47.8 % passed on one or more favorable ones.
Although rumor transmitters who friends and not friends passed on rumors different to the original one in the same degree, the predominant tendency is for friends to transmit favorable rumors and not friends, unfavorable ones.

2.1.2.4 Distortion of the implanted rumor

In the interview with each student, no indicator of rumor distortion was recorded. This was true in the 96 interviews. In every case, the interviewer was transmitted the rumor in its original version, without embellishment or variation. Although in fact new and extravagant rumors did appear, the implanted rumor was intact after one day. In a study on war rumors, Caplow expressed that "*the truthfulness of rumors was not reduced during transmission*". Even though he points out signs of distortion, his predominant impression is that of a marked lack of distortion[164].
This findings are directly opposed to the widespread impression that rumor is an unreliable way of communication, greatly distorted at times.
According to Schachter and Burdick, these results may indicate that such experiments as Allport and Postman's are arguably rumor transmission paradigms; they suggest that the result of their studies are not directly applicable to field situations where rumor transmission starts willingly and is subject to various corrective tendencies.

[164] Theodore Caplow, "Rumors in War", *Social Forces*, vol. 25, Nº3 (March 1947), pages 298-302

Caplow, in reference to the discrepancy between his findings and those belonging to Allport and Postman[165], suggests two mechanisms through which distortion can be eliminated or prevented during the course of rumor transmission[166]: a) "*Every individual from a channel hears the rumor more than once and passes it on more than once. This re-circulation tends to eliminate variation...*" and b) People related to previous inaccuracies or exaggerations tend to be excluded from rumor transmission channels.

In Schachter and Burdick´s opinion, other factors can account for the differences[167]:

a) The complexity of the narration transmitted. In laboratory experiments, the material passed on contains detailed and complex images or stories. Field studies show that implanted rumors have been relatively simple, lacking complexity and limited to a minimum of irrelevant details. The leveling process (omission of details in serial reproduction) is probably more evident when the material being passed on is very detailed and complex.
b) The nature of the driving force to communicate. In laboratory experiments, individuals communicate the content of the image or story exclusively to follow the tester's instructions. In field studies, subjects communicate in response to their own initiative. Individuals will presumably pass on a rumor on their own initiative only when its content is of some interest. In a study using serial transmission, Higham[168] says that there is less distortion when the individual self is involved and they are interested in the content of the communication.

2.1.3 Synthesis

In a field experiment, Schachter and Burdick tested the current concepts on rumor diffusion and distortion. They started with the assumption that rumors spread when there is *cognitive unclarity* in connection with an *important problem* and it is shared by *all group members* or most of them. Their research indicated that rumor transmission is greater and more speculation towards new rumors if there is cognitive unclarity and the problem is important as compared to cases when there is not.

Surprisingly and in contrast with the expectation created by other studies using serial reproduction techniques, rumor distortion was not recorded in any case.

The authors suggest several reasons for this behavior and they do not discard the distortion process.[169]

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[165] G.W. Allport and Leo Postman, *The Psychology of Rumor (op. cit)*

[166] Theodore Caplow, *op. cit.*

[167] Stanley Schachter and Harvey Burdick, *op. cit.*

[168] T. M. Higham, "The Experimental Study of the Transmission of Rumor". In*: British Journal of Psychology* (1951).

[169] Stanley Schachter and Harvey Burdick, *op. cit.*

2.2 The Procter & Gamble Case

Procter & Gamble is a U.S.-based multinational corporation, leader in the consumer product industry. With a range of 300 different products in the cleaning, paper, beauty, food and beverage industries, P & G ´s turnover amounted to u$s35.8 billion in 1997 with of u$s3.4 billion of net profits. At present, P & G operates in 70 countries.
P & G landed in Argentina in 1990 after the purchase of Shulton (Old Spice); it accounts for 20% of the soap and detergent market, while Unilever, its “enemy”/competitor accounts for the remaining 80%.

2.2.1 The Company’s History

In 1837, the noisy city of Cincinnati -600 kilometers west of Washington- was involved in the financial panic spread countrywide. Hundreds of banks had closed and the general perception was that the country was going bankrupt. In these circumstances, two puritans, William Procter and James Gamble, British and Irish immigrants respectively, decided to create a company whose main concern was not to defeat the financial market but their 14 competitor soap manufacturers.
In 1890, the Procter and Gamble partnership had become a multimillionaire corporation. By then, the company had sold over 30 different types of soap, including the successful Ivory brand.
With the aid of strong advertising campaigns, using color advertisements in magazines, which was completely innovative by then, P & G extended its operations outside Cincinnati, and opened industrial manufacturing plants in Ontario, Canada. A laboratory for new product development was introduced in 1917; this led to the continuous launch of new products, including a vegetable oil, which changed American cooking habits.
By 1945, P & G had introduced market research to know consumers’ real needs and started to sponsor radio shows (and, later, TV shows), which came to be known under the name of “soap operas”.
At the end of Second World War, Procter’s turnover exceeded 350 million dollars and its products were popular in the United States and Canada.
In 1946, P & G introduced Tide, the most important product after Ivory. As Tide was remarkably superior to any other product in the market, it became a sales hit. The same occurred with Crest toothpaste -the first to introduce fluoride in its formula- and Pampers.
At the beginning of the 60´s, the company expanded their activities to the food and beverages industry.
By 1980, P & G recorded sales for u$s11 billion and carried out businesses in 23 countries worldwide.
Two years later, in 1982, the company became an important competitor in the pharmaceutical market after the acquisition of Norwich Eaton Pharmaceuticals and Richardson-Vicks two years later. Other acquisitions, such as Noxell, Max Factor and Ellen Bertrix at the beginning of the 90´s, helped P & G’s global strategy.
Today, P & G’s research and development centers in United States, Europe, Japan and Latin America ensure the company’s worldwide leading position.

2.2.2 Satanism

To understand the relevance of the rumor affecting P & G, it is necessary to analyze the phenomenon known as Satanism and its relative importance in the American society.
Satanism is a widely spread concept; however, very little is known by the U.S. public. Confusion derives from the different meanings of the definition of Satanism, since popular culture has mixed these definitions and a general misunderstanding was created.
According to American sociologists Shanon and Rose-Roeber (1997), Satanism can be divided into three main categories:

a) Religious Satanism:
   In the U.S., there are three self-proclaimed satanic organized groups: The Church of Satan; The Temple of Set and the Church of Satanic Liberation. The religion exercised by their members is based on Satan's concept from the Ancient Egypt rather than the Jew-Christian devil.
b) Medieval or Gothic Satan:
   The Middle Ages produced a Satanism imaginary combining the Christian concept of the Devil and highly distorted views of the old Pagan faith. It was believed that this devilish religion practiced rituals such as children sacrifices, the sale of souls to the Devil, the ill intended destruction of crosses and the celebration of black masses, among others. There is no evidence of the existence of this religion in the past or in the present.
c) Popular Satanism culture:
   At present, the American Anglo-Saxon popular culture has produced a version of Satanism that has brought elements back from medieval Satanism and has mixed them with other new elements. One of its forms, for example, is the youth rebellion called "teenager Satanism", expressed through Satanic rituals with devilish attire. Another is the so-called "contemporary satanic legends"; it is a type of mythology aimed at explaining the presence of the Devil in society. Horrible and ruthless crimes, such as child abuse, sexual harassment, the mysterious disappearance of children or serial killings are usually attributed to Satan's influence.[170]

In this way, the idea that the term "Satanism" should be linked to the devil, destruction and horrible murders has become popular in the American society. The origin of this belief, which has little or nothing to do with religion, is the big number of groups that claim to be Satanic. Robert Balch, from Montana University, has done research on Satanism. In the Rocky Mountains, people accused Satanism for a series of frightening events including murders, attacks and missing people. According to this author, speculation on these evil events has continued since the beginning of the 70´s.

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[170] *In a recent article, Marcelo Diament refers to the explanations for the existence of Satanism in the USA: "The bad reputation of politicians, the decay of the traditional family structure, ethnic diversity, the legitimization of alternative forms of sexuality, the drug and violence culture, and the impact of technology are the issues mentioned as the root causes of the disappointment and frustration feeling in the American society. The strengthening of religious fundamentalism and the tendency to accept the text of the Bible literally seem to reflect the need for simpler and definite answers in view of a reality that reveals itself as more and more complex and ambiguous".*
Marcelo Diament, "Darwin is Still a Source of Controversy in the USA. The Old Debate around "Evolutionism" is back". Newspaper article in Spanish in: *La Nación*. (Buenos Aires, August 21, 1999. Page 4).

Many American fundamentalist churches have tried to confront the increasing interest for the occult. Many of them have even produced films with messages warning their followers about the control exercised by Satan in the world.

2.2.2.1 Satanism Diffusion in the United States

In the United States there have been numerous cases of people involved in certain types of Satanism. According to Shanon and Rose-Roeber, these young people -mostly teenagers- consider Satanism as a form of rebellion. They combine elements from the religious Satanism, the medieval Satanism with ceremonial magic and any other element and source that they may find. It has been estimated that there are thousands of these groups in the U.S. although they are not connected with each other.

Some felonies such as vandalism and graffiti have been attributed to these groups.

Some heavy metal rock bands resort to Satanic symbols as a way of promotion among young people and to increase their popularity and sales. In the 80's, Kiss stood out as an example of such groups. But there is no connection between an organized religion and rock bands. However, in 1982, James Gilbert, the Youth Minister of The Christian Church in Kaufman, a city of 5,000 inhabitants in the Southeast of Dallas, expressed he was intrigued and "fearful" of the subliminal messages hidden in rock music. He was specially surprised by what he called the "backwards camouflage" technique. A New Orleans newspaper reported the testimony of this 28-year-old minister: "*Camouflage is evident for the conscious mind when records are played backwards. Instead of the meaningless sounds usually heard in this type of version, words are clearly distinguished. These messages cannot be heard with the conscious mind when the record is played as usual, but they are caught by the subconscious mind. When played backwards, a line of Led Zeppelin's 'Stairway to Heaven' says: 'I will sing because I live with Satan'. The second part of the song played backwards says: 'There is no escaping it, my sweet Satan. The one will be the sad one who makes me sad, whose power is Satan* "[171]

In the spring of 1983, the TV program "Entertainment this Week" dedicated a space to the controversy between fundamentalists and rock group Kiss on this issue of Satanism and subliminal devil messages. It seems that the way in which Americans receive the most information on Satanism is through rumors spread in the media.

This is related to a tendency that emerged in the 60´s, when churches started to become increasingly popular.

After the Jonestown episode in French Guyana, when a whole community (The Temple People) committed collective suicide driven by their leader, Jim Jones, the term "cult" started to be linked to the concept of a group led by a manipulator whose intellectually brainless followers are subjected to a maximum level of obedience[172].

In the United States fear about these groups grew even more when mutilated cattle was found in the west of the country; it was attributed, by means of a rumor, to Satanic group members. Satanic rumors kept on circulating. After the well-known Procter & Gamble case, subject of this analysis, other rumors, such as McMartin case, were widely published

[171] Betty A. Luman, "Rock: Backward Road to Depravity"; U.P.I. *New ºOrleans, Time-Picayune/ States- Item Spotlight* (January 8th, 1982) page 3; cited in Fredrick Koenig, *Rumor in the Marketplace: The Social Psychology of Commercial Hearsay* (London, Auburn House Publishing Company, 1985), page 65

[172] Jeffrey S. Victor, *The Creation of Contemporary Legend*. (Chicago, Open Court, 1993).

in newspapers and magazines of the United States,. It was a public trial filed against a group of people accused of Satanism and child abuse in a care center.
Today, the sole typing of the word “Satanism” in any Internet browser is enough to find dozens of pages dedicated to this issue.

2.2.2.2 Satanism and the Moon Church

The rumor about P & G’s connection with Satanism, purporting that the company’s president had spoken about it during a well known TV program related the word moon - essential part of P & G’s logo- to the Moonies and its founder, “the Antichrist embodied”.

Sun Myung Moon’s followers (three million worldwide) call him and his wife, the old *Hak Ja Han*, the “true parents” of humanity. Born in 1920 in North Korea, Moon states that he was proclaimed the new Messiah by Jesus Christ when he was 16. Expelled from the Presbyterian Church, he was sent to prison by the local Communist Regime. He founded his church in South Korea in 1954, and called it *Federation of Families for the World Peace and Unification,* based on the premise that communists are Satan’s instruments and that his divine mission is to promote capitalism and a conservative theocracy.
Several followers’ parents accused the Church of brain washing. “Moonies” abandon their independence, they live in centers that belong to the Church, sell flowers at airports and they even let the Church’s elder members choose their spouses. Some husbands and wives even speak different languages and they communicate through interpreters.
On July 1, 1982, the Reverend Moon first celebrated the simultaneous wedding of 2,075 couples in the Madison Square Garden, New York. The brides wore identical white dresses; the grooms, blue suits. The ceremony also gave holy orders to the newly weds who became missionaries of the Unified Church. Moon proclaimed that the families to be created “would expand in a true society, a true nation, a true world”. The massive wedding was condemned by New York Jewish and Christian communities.
Moon, whose New York based empire is composed by a fishing fleet, newspapers, companies devoted to *gingsen* export (plant original from Korea; its root is very appreciated for its tonic and aphrodisiac qualities), and manufacturing of war weapons, was accused of misdemeanor and sentenced to a year and a half imprisonment in 1984. His attempts of “subversion of the American government” (as expressed in a speech) through a network of right wing organizations alarmed many people.
The allegation involving the Moonies is very similar to the ones in connection with Satanism. It has to do with the corporate connections of a group regarded to be threatening by some United States communities. The people who fear Satan, according to Koenig, tend to believe that a Satanic movement exists, although it may not be visible.
On the other hand, Reverend Moon´s Church of Unification does exist. There is no need for spiritual experience or for being threatened. Why do people feel uncomfortable towards the Church of Unification? Because it is an “external group”, it is “them”, an *alien*. People of low educational level in particular tend not to believe in foreigner or aliens. In addition, it is a relatively new and unknown religion whose origin is the Far East. The public in general does not know much about the Moon Church, but that it is a powerful organization, with a considerable number of members and big financial interests and that performs massive weddings whose participants wait for a year’s time to consummate the marriages. There is also additional fear due to the recruiting methods employed by the Moonies.
To summarize, one thing is to be an obscure and plain religious group; but to be a powerful religious group is another.

On the other hand, kidnapping and brainwashing of young people cause concern among parents. The combination of these characteristics turn members into the target of fear and hostility. These feelings are emphasized in places where the presence of the cult is more evident. Rumors related to *Moonies* often take place in areas where they have purchased property or they carry out commercial operations affecting the nearby population[173].

2.2.3 The facts

The case of rumors that harmed Procter & Gamble is probably the most extended, the most promoted and the most expensive in the market. In fact, it involves two rumors: one is about Procter & Gamble's connection with the Church of Unification, the other about its connection with the Church of Satan. The Moon-Satan convergence union had a peculiarly dual development in the early stage of the Procter & Gamble case.

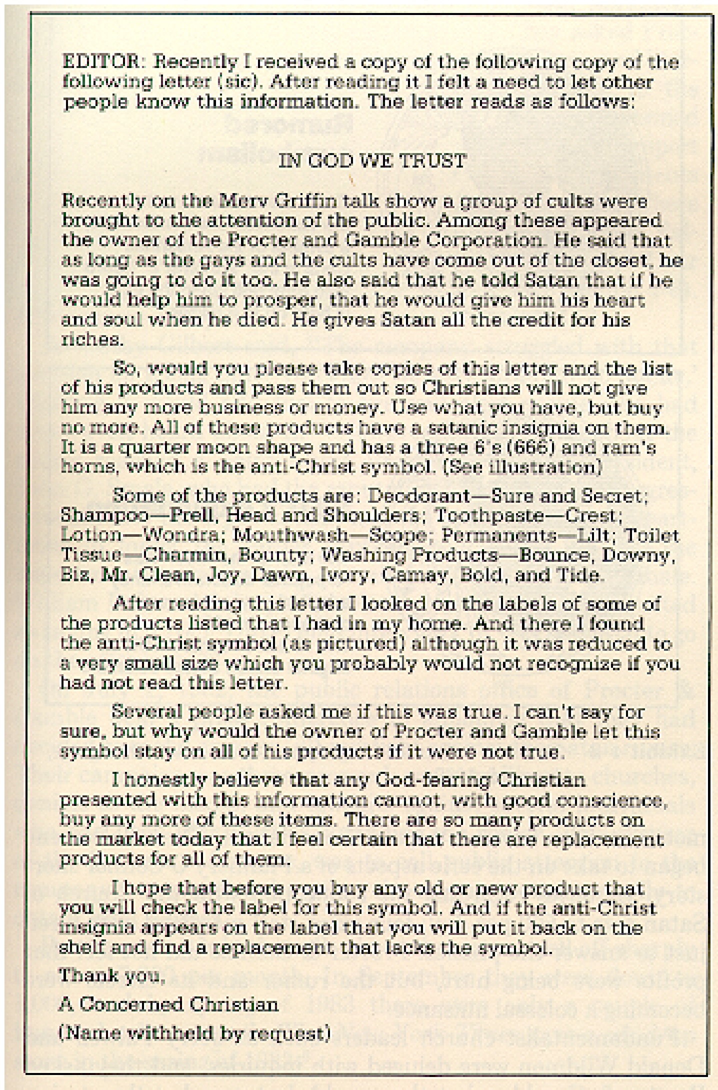
According to Cathy Gilbert, responsible in P & G for this case, the problems with the logo started at the beginning of 1979, when her department received claims from three reporters and six clients in Florida about the properties owned by the Moon Church because the Church of Unification had purchased properties in Florida by then. During the rest of 1979, Procter & Gamble received half a dozen calls from all over the country about the Moonies. From January to March, 1980, they received 33 calls relating P & G to witchcraft and/or the Church of Satan. One of the promoters of rumor circulation was a Minnesota parson called Wynn Worley, who admitted he had spread information among his followers about the idea that the P&G logo symbolized witchcraft. In spite of the sound refutation from the company, the rumor persisted. Then, the minister partially took his words back and expressed that Procter & Gamble might not be connived with the devil but -whether they were aware of it or not- their trademark stood for what he said it stood for.
During 1980 the cards and letters kept coming in, at a rate of a hundred a month. Sometimes they connected the logo with Satanism; others with the Moonies. The Satan-witchcraft version faded somewhat as the year passed, while the Moon Church version grew.

2.2.3.1 Rumor Dynamics on P & G

Then, in October of 1981, the rumor dynamics accelerated exponentially, originating a crisis. In the Northwest Pacific the rumor became more specific and elaborate. It was the rerun of the first version, related to the "Phil Donahue Show" as the attributed source. The owner of P&G had supposedly appeared on the show and admitted that he contributed 20 % of the company's earnings to the Church of Satan in exchange for the Devil's aid to multiply the company's profits. Not surprisingly, the actual head of Procter & Gamble was never identified: very few people knew who he was and he had never been on television. The rumor moved quickly to the Midwest and the South with the attributed source tending to be most often the "Phil Donahue Show", but sometimes "Merv Griffin" or "60 Minutes".

[173] Fredrick Koenig, *Rumor in the Marketplace: The Social Psychology of Commercial Hearsay* (London, Auburn House Publishing Company, 1985), page 39- 72

By spring of 1982, the rumor was spreading like wildfire in Texas, Oklahoma, and the Southeast “Bible Belt”. Exhortations were made from pulpits and calls for boycotts hit the Fundamentalist Christian church newsletter network. These church newsletters began to offer similar formats to expose the Satan connection. Usually, they would reprint an anonymous letter received at the church, referring to the events on “The Phil Donahue Show”, “The Merv Griffin Show” or “60 Minutes”.



EDITOR: Recently I received a copy of the following copy of the following letter (sic). After reading it I felt a need to let other people know this information. The letter reads as follows:

IN GOD WE TRUST

Recently on the Merv Griffin talk show a group of cults were brought to the attention of the public. Among these appeared the owner of the Procter and Gamble Corporation. He said that as long as the gays and the cults have come out of the closet, he was going to do it too. He also said that he told Satan that if he would help him to prosper, that he would give him his heart and soul when he died. He gives Satan all the credit for his riches.

So, would you please take copies of this letter and the list of his products and pass them out so Christians will not give him any more business or money. Use what you have, but buy no more. All of these products have a satanic insignia on them. It is a quarter moon shape and has a three 6's (666) and ram's horns, which is the anti-Christ symbol. (See illustration)

Some of the products are: Deodorant—Sure and Secret; Shampoo—Prell, Head and Shoulders; Toothpaste—Crest; Lotion—Wondra; Mouthwash—Scope; Permanents—Lilt; Toilet Tissue—Charmin, Bounty; Washing Products—Bounce, Downy, Biz, Mr. Clean, Joy, Dawn, Ivory, Camay, Bold, and Tide.

After reading this letter I looked on the labels of some of the products listed that I had in my home. And there I found the anti-Christ symbol (as pictured) although it was reduced to a very small size which you probably would not recognize if you had not read this letter.

Several people asked me if this was true. I can't say for sure, but why would the owner of Procter and Gamble let this symbol stay on all of his products if it were not true.

I honestly believe that any God-fearing Christian presented with this information cannot, with good conscience, buy any more of these items. There are so many products on the market today that I feel certain that there are replacement products for all of them.

I hope that before you buy any old or new product that you will check the label for this symbol. And if the anti-Christ insignia appears on the label that you will put it back on the shelf and find a replacement that lacks the symbol.

Thank you,

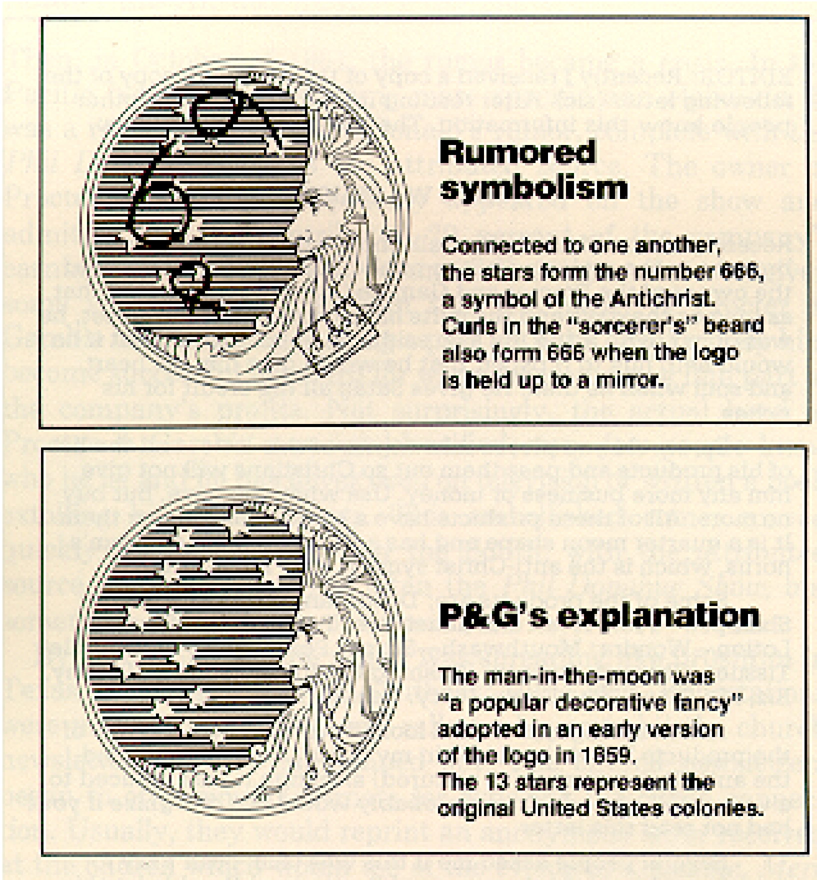
A Concerned Christian

(Name withheld by request)

An anonymous letter received in numerous Midwest churches in early 1982[174]

Later versions had this additional touch: The Procter & Gamble logo was redrawn to show the figure 666, “the sign of the Beast” according to the Book of Revelations. The hidden demoniacal code number derived from the original design by playing “connect the dots” with the thirteen stars and drawing the lines between them to form the three-digit code.

[174] Fredrick Koenig, *op. cit.*, page 43

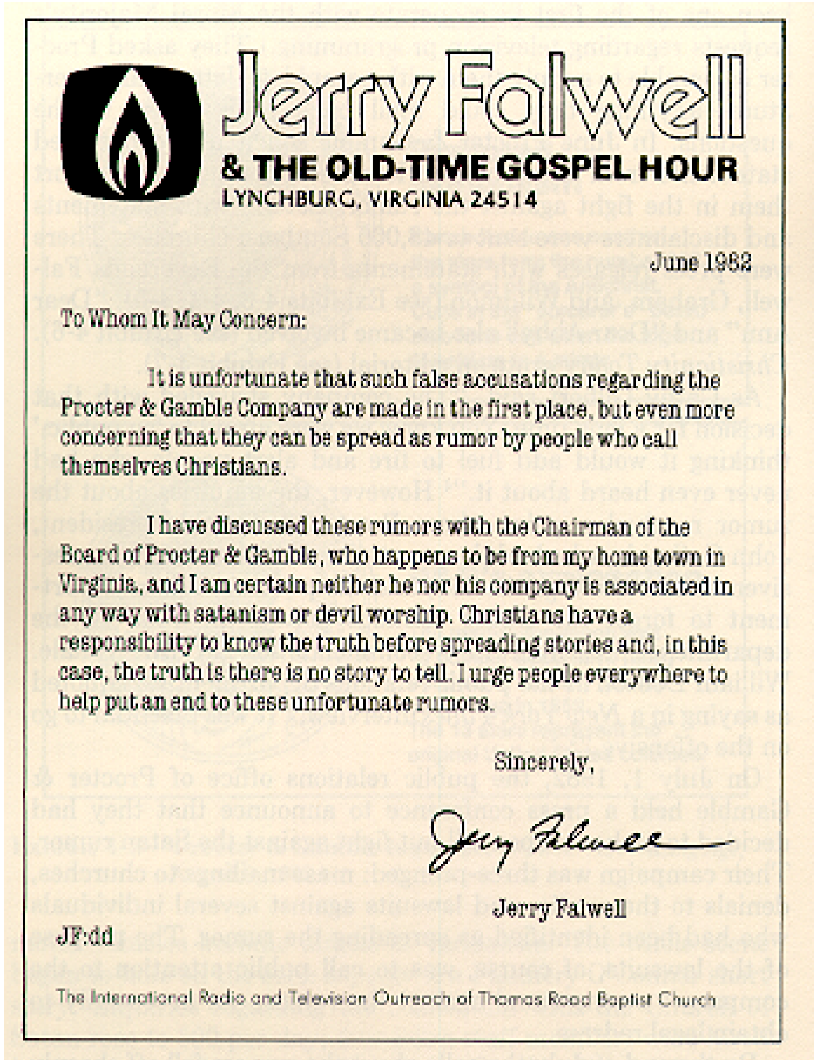


It was also pointed out that a close look at the mirror image of the curls on the man in the moon depicted three "6"s. The rumor was recycled by other church newsletter editors and it rapidly multiplied[175].

Although sales representatives spent much of their time trying to convince retailers that the company was not connected with the Devil, they were frequently turned away or warned that their products were being returned. Procter & Gamble motor vehicles became targets of vandalism. Inquiries regarding the connection with the Church of Satan rose to 500 per day and four extra staff members were hired just to answer the phones. Procter & Gamble did not feel that profits were being hurt, but the rumor and its effects were becoming a colossal nuisance.

Fundamentalist cyber church leaders such as Jerry Falwell and Donald Wildmon were deluged with inquiries, and they asked Procter & Gamble what they could do to combat the stories, since the working relationship between Procter & Gamble and the Moral Majority was a good one because that company had been one of the first to cooperate with the Moral Majority's request regarding television programming. They asked Procter & Gamble to supply them with pamphlets, letters and literature – anything they could mail back in response to the questions.

[175] Fredrick Koenig, *op. cit.*, page 44



Jerry Falwell
& THE OLD-TIME GOSPEL HOUR
LYNCHBURG, VIRGINIA 24514

June 1982

To Whom It May Concern:

It is unfortunate that such false accusations regarding the Procter & Gamble Company are made in the first place, but even more concerning that they can be spread as rumor by people who call themselves Christians.

I have discussed these rumors with the Chairman of the Board of Procter & Gamble, who happens to be from my home town in Virginia, and I am certain neither he nor his company is associated in any way with satanism or devil worship. Christians have a responsibility to know the truth before spreading stories and, in this case, the truth is there is no story to tell. I urge people everywhere to help put an end to these unfortunate rumors.

Sincerely,

Jerry Falwell

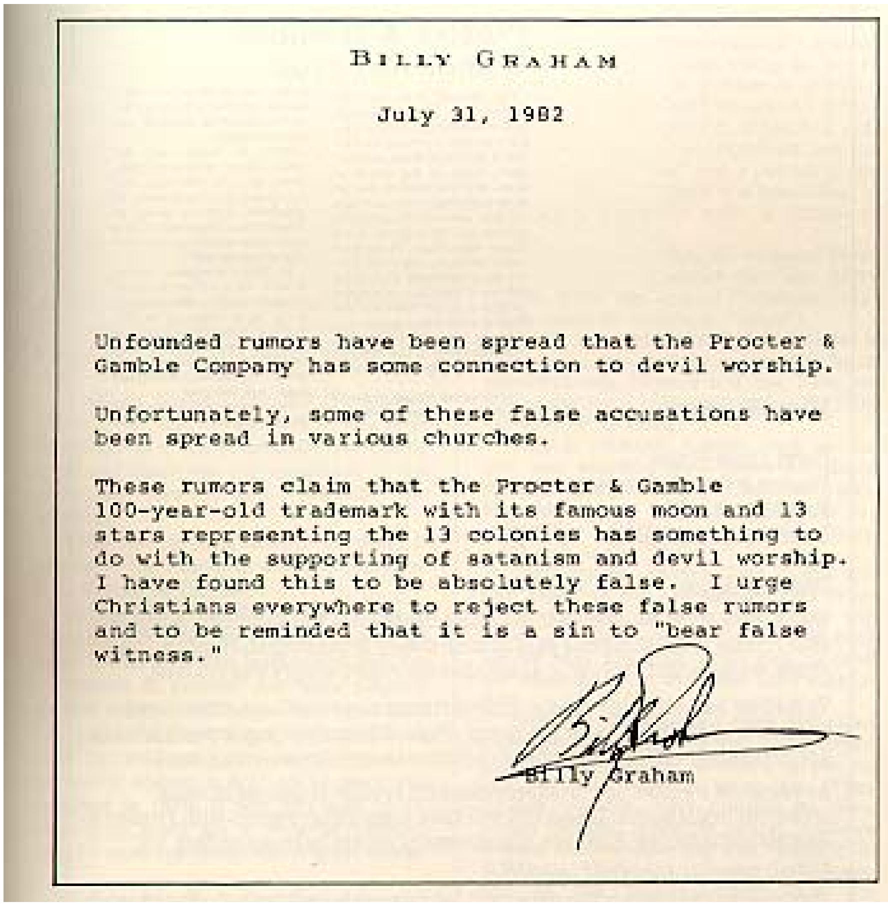
JF:dd

The International Radio and Television Outreach of Thomas Road Baptist Church

Letter of Jerry Falwell Baptist Church TV program to its followers[176].

In June, Procter & Gamble requested and obtained statements from these church leaders and others to support them in the fight against the rumor. Letters with statements and disclaimers were sent to 48,000 Southern churches. There were press releases with statements from the Reverends Falwell, Graham and Wildmon. “Dear Ann” and “Dear Abby” also became involved and “Christianity Today” wrote an editorial.

[176] Fredrick Koenig, *op. cit.*, page 46



BILLY GRAHAM

July 31, 1982

Unfounded rumors have been spread that the Procter & Gamble Company has some connection to devil worship.

Unfortunately, some of these false accusations have been spread in various churches.

These rumors claim that the Procter & Gamble 100-year-old trademark with its famous moon and 13 stars representing the 13 colonies has something to do with the supporting of satanism and devil worship. I have found this to be absolutely false. I urge Christians everywhere to reject these false rumors and to be reminded that it is a sin to "bear false witness."

Billy Graham

Cybernetic preacher Billy Graham disqualifying the rumor[177]

As Cathy Gilbert said, “The company struggled with that decision for a long time. We were afraid to “go public” thinking it would add fuel to the fire and alert people who had never even heard about it”. However, the inquiries about the rumor reached a point where Procter & Gamble’s president, John G. Smale, who had the reputation of injecting new aggressiveness into the organization, told the public relations department to forget the early cautious policy. On June 10th the department presented the recommendation to Mr. Smale.

On July 1st 1982, the public relations office of Procter & Gamble held a press conference to announce that they had decided to make an open, all out fight against the Satan rumor. Their campaign was three pronged: mass mailings to churches, denials to the media and lawsuits against several individuals who had been identified as spreading the rumor. The purpose of the lawsuits, of course, was to attract public attention to the company’s strong stand against the rumor, not necessarily to obtain legal redress.

[177] Fredrick Koenig, *op. cit.*, page 47

The Terrible Truth about that Procter and Gamble Symbol

It's not Satanic; the Moonies don't own the company.

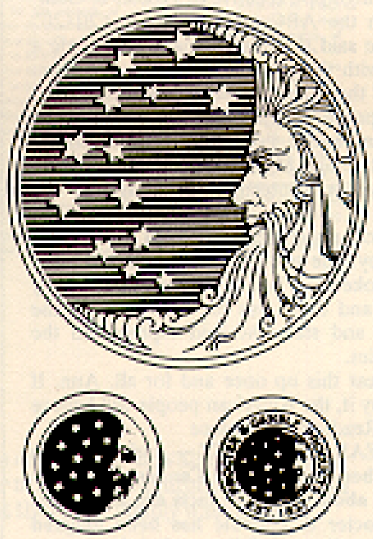
Apparently Christians easily forget that gossip is a sin, and some of America's largest marketing firms are plagued by the consequences.

For the second time in as many years, Procter and Gamble Company, the consumer product manufacturing giant, has been targeted by a campaign of unfounded rumor. The current wave, which began last October, charges that P & G actively promotes Satanism. It is circulating in the Pacific coastal states and typically alleges that a P & G executive appeared on either the Phil Donahue or the Merv Griffin television talk show and publicly linked P & G with promotion of Satanism.

Statements have been issued by spokesmen for both the Donahue and Griffin programs to deny that they had ever interviewed a P & G official.

The tenuous basis for the rumor is apparently the P & G corporate symbol: a man-in-the-moon profile and 13 stars. The rumor mongers claim this is a sorcerer's head and that the number of stars is of significance in Satan worship. Actually, according to P & G spokeswoman Kathy Gilbert, the 13 stars were chosen in the 1850s to represent the original colonies, and the man-in-the-moon was tossed in by William Procter and James Gamble because it caught their fancy. The man-in-the-moon profile was a fad at the time—much as the happy face is today.

A year earlier, the Cincinnati, Ohio–based P & G was subjected to a spate of rumors, largely from the upper Midwest, alleging that the firm had been bought out by Sun Myung Moon's Unification Church. P & G, which markets products such as Folger's coffee, Ivory soap, Head & Shoulders shampoo, and Pampers disposable diapers, has never been approached by the Moonies.



The P&G corporate logo, which first evolved in 1851. At lower left is the 1882 version, the one registered in the U.S. Patent Office, and at right, the 1920 model.

In both cases, Gilbert said, the inquiries came from individuals who typically stated that they "heard it at their church over the weekend." She observed that they referred to "fundamentalist-type churches," and that a few of the churches had attempted to organize boycotts of P & G products.

Sales have not been perceptibly affected by the rash of rumors, but P & G officials, taking no chances, have spent several hundred dollars to combat the slander. "It's a lot cheaper to fight the rumors than it is to have the corporate symbol redesigned," said another company spokesperson.

Christianity Today Article, April 9, 1982[178]

By the end of July the calls about the rumor fell sharply to about 7,000 per month. In September they were down to 1,000, and by spring of 1983 there were only a couple of hundred calls a month. The *New York Times* gave a wind-up story in the spring of 1983:

[178] Fredrick Koenig, *op. cit.*, page 50

"*Most lawsuits, filed against seven individuals believed to have spread the rumors, have been resolved. One, against an Atlanta weatherman and lay minister, was settled when he made a public apology. Most others, against distributors of competing household products, ended in similar consent decrees. But charges against Linda Moore, an independent Amway dealer, are still pending.*"

"*Satan's effect on Procter's business is difficult to gauge. Sales and earnings have improved since 1980, and earnings for the quarter ended last September 30 rose 15.2 percent, but the company says last summer's publicity and legal campaigns cost millions. "It has certainly been a major distraction to our business, said Mrs. Ulrey (a spokeswoman who was interviewed).*"

On October 25th of 1984, the *Wall Street Journal* published a story about P & G that briefly described the problem:

"*It's bad enough to have to report a drop in earnings. Procter & Gamble Co. also has to convince people it isn't giving money to the devil.*

The idea that the company's "man in the moon" trademark is linked to the Church of Satan -a rumor that started in 1981- has returned to plague P & G.

The company has answered 3,000 calls this month from people who believe P & G is in league with the devil. More specifically, the callers say, they have been told that the company's chief executive officer, John Smale, appeared on ´60 Minutes' or 'Good Morning, America' or the ' The Phil Donahue Show', saying that he is a member of the Church of Satan, that the company contributes money to the church and that 'there aren't enough Christians in the world to stop it'. Callers also say they've been urged to boycott P & G products".

That week's issue of *Advertising Age* had a front-page story, "Rumor returns to bedevil P & G". The article reported increases in inquiries about the Satan connection to about 1,000 in September and to 3,000 in October.

A call to Bill Dobson at P & G revealed that, indeed, they did 'have a problem'. Although it was not as bad as in the two previous years, they wanted to deal with it locally before it spread further. He said they were sending out mailings describing the history of the logo, a disclaimer to the *Phil Donahue Show* component of the story and the old letters from evangelist Billy Graham and Jerry Falwell. The irony of the latter move is that the trouble seemed to be coming not from fundamentalists this time but from Catholics. In areas such as western Pennsylvania, Buffalo, Cleveland, Chicago and Nebraska, nuns and priests were putting notices in newsletters and church bulletins, urging their students to go home and tell their parents to boycott P & G products because the president of the company said that there weren't enough Christians "to affect his alliance with the Church of Satan". Later, *The Wall Street Journal*[179] did a feature story on the problem and presented the case of Sister Domitilla Drobnsk. According to the article, the headmistress of St. Anthony's elementary school in this mining town east of Pittsburgh, did not know who had put the leaflet in her mailbox six weeks ago. But she did know what she had to do when she got it.

The leaflet described how the president of Procter & Gamble Co. had appeared on the *Phil Donahue* show to declare his company's support for the Church of Satan. And it showed a magnified picture of P & G's "man in the moon" trademark, which according to the leaflet was the sign of Satan.

[179] "Devil Rumor Haunts P&G", *Wall Street Journal* (October 25th, 1984); cited in Fredrick Koenig, *Rumor in the Marketplace: The Social Psychology of Commercial Hearsay* (London, Auburn House Publishing Company, 1985), page 47

So Sister Domitilla made copies of the leaflet and added a note of her own, urging a boycott of P & G products. She sent 70 copies home with St. Anthony's students. "I thought I was going to fight for social justice", she would say.

When describing her reaction to the contents of the accusation, Sister Domitilla said that she was shocked and that she wanted everyone to know what people think about Christians. "We have to be stronger in our faith", she said and signed her name to a note urging other Christians to "prove we do make a difference".

There was a noticeable transformation of the message each time P & G was plagued. The first version was a vague claim that the logo was a witchcraft symbol. The second version, a couple of years later, was a specific "revival" of the company president visit to the *Phil Donahue Show*, etc. As this series made the rounds, however, it was obvious to most people how foolish it would be for a corporation official to confess such a thing on national television and thereby jeopardize his business. Therefore, a new rumor appeared and involved the president commenting on the inability of all Christians in the world to undo his pact with Satan. This taunt seemed to have considerable capacity to create outrage among Christians who heard it.

What caused the resurgence of P & G's problem in 1984? The rumor had been around for a long time, and during that period sparks had been allowed to scatter far and wide. When the public relations people decided to put out the fire, there were areas around the country they could not reach, and the rumor was latent. Catholic nuns and some priests, for example, had not been party to the campaign directed at fundamental congregations in the previous couple of years. Because they have a moderately reclusive lifestyle, they probably were untouched by the national media blitz that P & G launched in the summer of 1982.

The anxiety brought about by frustration and stress increased the likelihood of rumor activity. In the 1984 election campaign, Catholics often found themselves in an adverse position concerning abortion, prayer and the role of religion in politics in general. They may have felt under attack and threatened. Also, unemployment and economic depression seemed to characterize the regions that were the centers of the rumor activity: "*the economy of Vandergrift"*, Father Weber explains, "*has been ravaged by the closings of a foundry and of the U.S. Steel plant". "So many people have lost their jobs",* he says, "*and so many are upset by the idea of nuclear war. To them, almost anything can happen. In searching for explanations, a lot can get to the point where they think they're being punished. It's easier to blame it on the devil*".

On April 24th 1985, Procter & Gamble announced its intention to remove the logotype from its product packages. The decision was made after a severe flare-up of the rumor early in 1985, resulting in thousand of phone calls to the company. The company's logo and its stars -created by its founders in 1850 representing the 13 States of the Colony- would be retained on company letterhead. Nevertheless, rumors came back and showed two peaks, in 1990 and 1995.

Up to 1995, Procter & Gamble answered almost 200,000 phone calls and letters related to the rumor. In May of the same year, 200 phone calls were received daily.

By the end of 1995, the company had filed 15 slander lawsuits. The last six were against Amway Corporation, the competitor distributor.

While the rumors on the Procter & Gamble's connection with the Moonies were of limited duration, the Satan rumor appears from time to time.

2.2.4 Synthesis

- Procter & Gamble is one of the largest consumer goods companies, specialized in household cleaning and beauty care. Its headquarters are located in the United States.

- Thirteen years after its 1837 foundation, it created a logotype to identify its products. It consists of a man in a half moon, a very popular illustration by then, and 13 stars representing the British colonies.

- In 1980 a rumor appeared in the South of United Sates, area known as the “bible belt”, and its origin is attributed to the fundamentalist Christian priests, who spread it in their sermons. As in the Middle Ages, the Church was the means for rumor circulation.

- The rumor related P & G with Satanism and expressed that the president of the corporation had spoken about this on a well-known television program. The rumor also associated the company’s logo with Satanic symbols, i.e. both the 13 stars and the curls on the man in the moon depicted three ´6´ s, the sign of the Beast, according to the Book of Revelation (Saint John, Chapter 13). On the other hand, the rumor related the word moon, essential part of P & G’s logo, to the Moonies and its founder, “the personification of the Anti Christ”.

- The company denied any connection with Satan, and leaders, religious organizations and cyber preachers even condemned the rumor publicly. The company also sent letters to the churches, published newsletters, arranged interviews and used any means to deny the invocation to the devil.

- Until 1995, P & G answered around 200,000 phone calls and letters related to the rumor. The peaks of rumor diffusion occurred in 1980, 1982, 1990 and 1995. In May of 1995, around 200 phone calls were received on a daily basis.

- Until 1995, P & G had filed 15 lawsuits for slander. The last six were against Amway Corporation, its competitor distributor.

- Procter & Gamble eventually modified the logo by eliminating the beard on the moon. Packaging material bore the new logo with the P & G letters. The company still uses the symbol of the moon and the stars in commercial stationery and internal communications.

- According to *The Detroit News,* the rumor did not affect the trust of P & G’s stakeholders. However, the same does not hold true for sales, which did suffer the consequences, although -and because- the company grew steadily, it is not possible to estimate the extent of the impact of the rumor on sales

- According to a study, 83% of the Americans living in New Orleans who knew of the P & G rumor and did not believe in it, had seen, heard or read the company’s denial. In contrast, only 54% of those who actually believed in the rumor, recalled having seen or heard the company’s disclaimer, although it was almost impossible to ignore it during the long lasting and intense denial campaign. This shows that for a rumor to be

believed there must be a willingness to do so, and that denials have little effect, as demonstrated by Kapferer in his research[180].

2.3 Lady DI's Death

2.3.1 The Facts

Diana, known as Princess Diana, Princess of Wales or simply Lady DI, died in a car accident in Paris in the morning of August 21st 1997. She was with her friend Dodi Al Fayed, the son of a wealthy Arabian tycoon living in London, escaping from the pursue of "paparazzi", photographers at the service of those tabloids that pay the most for their photos.
The driver also died in the accident that took place in one of the tunnels crossing the Seine River; the bodyguard of the couple was badly injured and he remembered very little after the accident.

2.3.2 The Rumor is Born

A few hours after the accident, the media reproduced the version that the vehicle driver was drunk.
Automatically, the public opinion triggered several questions:
Why did Dodi Al Fayed allow the chauffeur to drive drunk? Why didn't the bodyguard give notice of his condition?
According to people close to Henri Paul, the driver, including the bodyguard, he did not use to drink in excess and he had even refused to drive whenever he had drunk.
If there was a hospital four streets away, why did they take Diana to a farther hospital?
The cameras in the tunnel should have documented the accident. Why were they not filming at that moment? Or if they were, why aren't there any tapes ?
A close friend of Dodi´s commented to an Arabian newspaper published in the United Kingdom that the couple had planned to get married that year. Was it true?
Was Diana 3 month pregnant as it is said?
If, as it is said, Dodi were her baby's father, his heir would have been the sister or brother of the future king. Would the "establishment" have permitted a Moslem to be related to the British Royalty? Would they have permitted the future king to have a Moslem step brother o sister?
Was there another car behind the couple's Mercedes Benz that intentionally bumped into it?
Were there chemical products spread on the tunnel road to make the vehicle lose control?
Is there a worldwide disinformation campaign aimed at confusing the public opinion and thus hide the true causes of the accident?

[180] Jean-Noël Kapferer, *Rumors: Uses, Interpretations & Images* (New Brunswick and London, Transaction Publishers, 1990)

Due to the caliber of the people involved (specially Diana Spencer), the Secret Services of both countries aided the French Police with full secrecy.
This silence, together with the huge (unsatisfied) information demand from the public brought about information voids that were later covered by a series of rumors. The speed of their diffusion was heightened via the Internet. A few hours after the accident, numerous newsgroups -where "surfers" place their opinions for everybody to read- already contained the most absurd rumors. AOL (America On Line), a service to surf on the Web, recorded more than 15,000 comments of all types placed by subscribers. A few days after the accident, special pages on the Internet to spread rumors fully described different versions of the reasons for the unfortunate event.

2.3.2.1 The Conspiracy Nation Example

One of these pages, Conspiracy Nation, by Sherman Skolnick, read that the accident had been intentional and that its origin was conspiracy (notice the predictable tone of the argumentation in the context of the conspiracy theory) .
"During the last few days I've been interviewing thoroughly well informed reporters from the United Kingdom, France and other countries (I promised I would never reveal their names due to the nature of the issue in question). They told me that numerous and outstanding UK reporters are aware of the fact that the British Secret Service murdered Princess Diana since they count with reliable sources in key official government positions.
I was told in detail by the reporters about the way they learnt how the murder was committed. However, we should analyze why the real story is not revealed on UK television, radio or newspapers.
Few people know that in Great Britain there is a law called The Official Secrets Act. Thanks to this law, the Government is empowered to order in the whole territory of the island that some items are forbidden to be discussed . At present, the topic subjected to this foul play is Princess Diana's and her husband to be deaths.
On the other hand, another topic forbidden to be publicly analyzed is how the Official Secrets Act operates. If the editor of a newspaper or a radio station manager or a television-programming manager considers that a topic is comprised within this law, he should immediately report it to the London Administration. If the Administration considers the information a "D-notice, the nationwide publishing of said information and any other related story would not only be banned but it would be subject to seizure. The law authorizes – through different procedures - the immediate seizure and closing of any office whether printing or spreading the censored story as well as the arrest of the publisher and key personnel involved in the reporting and spreading of the story".
The worst part is that the rest of the media is not allowed to report on the arrest of these people and the seizure of their facilities. In other words: the discussion of a "D-notice" is forbidden as well as the technical procedure of the Official Secrets Act. Censorship rules over censorship instruments.
The reporters I have talked to agree on what other sources have provided me regarding Diana's murder. It seems that another vehicle intended to protect the former princess, actually transported British Intelligence agents. At a certain moment it bumped against the Mercedes ahead and they somehow collided.
In the meantime, the tunnel pavement became slippery since it had been covered with some chemical product. At the end of the tunnel there was a heavy stoppage that had been placed by a group of construction workers. While other drivers managed to avoid the stoppage, Diana's car failed to do so.

After the accident, the British Intelligence Service started a worldwide disinformation procedure (which is still on); they said that the car belonged to a tramp, that it had been previously stolen, that it was a defective vehicle, that the driver was drunk, that the speedometer showed 120, that the car was speeding over 150 km, etc.). There are several false stories promoted by the British Intelligence that have circulated in the United States thanks to CIA's cooperation.
Leading UK reporters agree with my story and others about Diana's murder. The simple reason of the murder lays in that the British Intelligence Service is devoted to protecting the monarchy. The British monarchy would not have a Moslem stepfather for the successor to the throne, Prince William.
In addition, it has been revealed that Diana had accepted an engagement ring from Dodi Al Fayed. What it is actually ignored is that she was already 3 months pregnant.
Now, if you mix all these ingredients, you reach the justification of why the British Intelligence Service is eliminating these people to protect the British monarchy under the 'national security' umbrella."

Computerized reconstruction of the accident

On January 13th 1998, British TV channel 4 broadcast a computerized reconstruction of the accident, intended to show the factual aspect of the accident (photo). It was useless. After some months, and according to two cables from EFE and AFP news agencies dated in London, 95 percent of the British people still maintained that the accident was the consequence of a complot.
In fact, according to a survey carried out among *The Mirror*'s readers, practically all the population of the island was convinced that there had been a conspiracy to murder the couple. Ten thousand people responded the nine-question survey conducted after two television programs dated on June 28th and 29th . While one of them speculated on the possibility of a complot, the other showed the exact opposite. 95.2 percent of the people agreed with the conspiracy theory, while 3.1 percent believed it was a tragic accident.
81.3 percent exonerated the paparazzi by responding 'no' to the question in connection with whether they thought photographers were involved in the accident; 98.9 percent believed that another car, the mysterious Fiat One, was related to the facts. In turn, 87 percent expressed they were sure of the Prince of Wales' intention of marrying Dodi Al-Fayed; 45 percent said that Diana would become a Moslem.

"According to the Argentine reporter Walter Goobar[181], "*in globalization times, the death of the princess of hearts has become a new planetary mystery that feeds the imagination of hundreds of thousands of anonymous cyber-fans searching for conspiracies typical of TV series such as 'X Files'. Although power constantly manipulates consensus, pluralism and equality that generates the illusion of a homogeneous scenario where rational individuals communicate via computers, the Lady DI case uncovers some of the most visible and numerous contradictions of this end of the millenium.*"

2.3.2 Synthesis

This rumor, as most of the ones circulating on the Internet, agrees with Knopf's Conspiracy theory model[182]. It also fits within the frame of Shibutani's theory[183] because, as previously said, it possesses all the ingredients: an unusual event, a highly interested public, an over-demand of news together with an (apparently) incomplete offer and an ambiguous situation; all these elements end up in an avalanche of rumors spread by a distressed and anxious public that tries to find and place the missing parts of the puzzle.

2.4 The TWA 800 Flight Case

2.4.1 The Facts

On July 17th 1996, at 8:47 p.m., still daytime and eleven and a half minutes before landing in JFK New York Airport, TWA Boeing 747 flight 800 exploded and fell in flames onto the ocean across from Long Island coast. Since then and up to mid November 1997 -when an FBI conference showed via computer that the cause of the accident had not been an attack- all types of rumors circulated on the Internet[184].

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[181] Walter Goobar, "Internet/ Lady Di and Dodi Al Fayed: The Queen of Conspiracies", article in Spanish in the Argentine newspaper *La Nación* (November 16th, 1997; Section 7, page 5).

[182] Terry Ann Knopf, *Rumors, Race and Riots* (New Jersey, Transaction Books, 1975)

[183] Tamotsu Shibutani, *Improvised News, A Sociological Study of Rumor* (Indianapolis- New York, The Bobbs-Merrill Co Inc, 1966)

[184] The plane accident of flight TWA 800 will be remembered as the most disastrous airplane even in the USA, because it involved an important international company and because the accident took place just three days before the opening of the Olympic Games in Atlanta 1996, during which actions from international terrorism were feared.
Boeing 747 to Paris plummeted into water around Long Island after the take off from JFK airport in New York, on July 17th 1996, burying with it its 230 passengers. The following day TWA started to notify relatives of the victims, after the Mayor of New York, Giuliani, voiced his criticism against the airline for not taking care of this aspect with the necessary diligence. The bad weather and the brave sea made the search for the bodies and the pieces of the plane very difficult and slow. The sonar, operated by the US Navy, located part of material, presumably from the wrecked plane, at the bottom of the sea. Investigators devoted to the case centered their suspicions on an explosive artifact as the possible cause of the accident. However, evidence found to support the hypothesis was very poor.

2.4.2 Internet's Instant Effect

Some minutes after the accident, which resulted in the death of 230 passengers, the Internet became a center of information and speculation where the most absurd stories were not absent.

While the factual reality of the mysterious story failed to be revealed by analysts (during 4 months, researchers did not do away with the idea that a bomb, a missile or a mechanical failure *"might have"* caused the accident), the virtual reality filled an information void.

With key words such as "TWA Flight 800", "missile", "bomb" or "conspiracy", thousands of messages were placed in newsgroups, to the extent that the issue was included in a page called "the 50 greatest conspiracies of all times".

Such a speculation was partially fed by the nature of some theories that were not categorically denied in their origin. For example, the "friendly fire" theory that says that an American missile erroneously thrown by the Armed Forces may have originated the accident was not denied; on the contrary, James Kallstrom, chief of the FBI research team, just said that "the version was highly improbable (but not impossible)".

Under these circumstances, and awaiting official information from FBI, the Bureau of Alcohol, Tobacco and Firearms and National Transportation Safety Board, computer users analyzed every detail that they obtained from the Web to reach their own conclusions.

According to Vincent Cannistraro, former CIA chief of anti-terrorist operations, the lack of concrete information encourages conspiracy theorists: "*They know the fact number one and number 4, but they ignore what is there in between them, so they start to fill the gaps*".

One of the reasons for rumor strengthening is the fact that the FBI itself made its e-mail address available for the cyber-fans to collaborate in solving the mystery. The result was a flood of data and speculations about meteors, extra-terrestrial beings, bombs or missiles while there was little information from pilots, engineers and other experts.

Thousands of messages were individually analyzed. According to Kallstrom, "*many of them were reasonable; others even deserved a second reading. But there is a strong*

During a week, after the moment of the accident, the investigations did not produce any significant and conclusive piece of evidence leading to the conclusion of an explosion on the plane. A total of 108 bodies were found. During that week, several theories and unfounded rumors circulated around the hypothesis of a terrorist act while the claims and complaints against TWA from the government agencies and medical experts involved, on behalf of the victims' families, because of the uncertainty and lack of information escalated.

On July 24th, the Navy recovered two "black boxes" corresponding to the plane recorder and the voice recorder in the cockpit. They did not show any evidence of trouble nor alarm sounds, however, and no precise conclusion could be drawn from the recording transcriptions.

Anyway, the version about the likelihood of a bomb or missile as the causes of the explosion on flight TWA 800 grew strongly during the period after the accident.

After a visit to the victims' families, President Clinton ordered - on July 25th - to reinforce security measures in all airports and flights. By July 31st, 171 bodies had been found and 165 had been positively identified. No evidence showed signs of a terrorist attack or malfunctioning as the cause of the accident.

Kim Yungwook; Kim Jihye; Park Jungki and Choi Youjin: "Evaluating Media Exposure: Applying Advertising Methods To Publicity Measurement". In *Corporate Communications*. (London, MCB University Press, Vol 4 Nº3. 1999). Page 136 - 144.

difference between an expert's evaluation and an eccentric's one. Some of these people are honest, serious and trained on how to conduct surveys via intellectual analysis; others are obsessed with senseless stories as those from "X Files" and do not make a concrete contribution."

This difference may be difficult to individualize in the Internet. On the other hand, due to the speed of transmission of telephone lines, speculation and rumor on the Web is much faster than on other media. Anyone can have access, suggest a conspiracy theory, "publish" it on a page dedicated to rumors and conspiracies or a newsgroup, or send it to an e-mail list of addresses; in this way, the version will start to circulate like an information virus.

Among the avalanche of rumors about the TWA 800 flight, the ones related with UFOs were included, since they are a classic on the Internet pages. According to one of the rumors, a woman living in the North of the New Jersey State said she had seen a UFO flying south of Long Island, where the plane would later crash and fall.

According to another rumor, placed 4 days after the accident in the "UFO ROUNDUP" page, some people -including a pilot of New York National Air Force- described a bright object flying towards the plane seconds before the explosion.

J. Orlin Grabbe, a lunatic Harvard graduate, has a page dedicated to conspiracies called "From the Desk of J. Orlin Grabbe" that generates and spreads all types of conspiracy theories developed by himself or by others. It is not something unusual; there are dozens of similar sites on the Internet.

According to Grabbe, highly educated people who read his page got in touch with him after one week of the explosion to report that a missile had shot down the TWA plane. Of course he denies being a conspiracy theorist. In his opinion, he attributes the attack to terrorist groups; besides, the radar photos distributed by FBI (showing the plane flying at 15,400 feet of altitude) were false since he had evidence that the Flight 800 was not above 7,600 feet (radars and satellites confirm that the altitude during the explosion was 15,400 feet).

John Barry Smith, from Carmel, California, is another Internet fan who lets his imagination fly in the Web. He believes that a loading hatch accidentally opened and decompressed the Jumbo, and the plane blew into pieces. Smith not only made his theory public via conspiracies pages but he e-mailed his explanation to the White House, FBI, FAA, the Air Force, NTSB and to the Airline insurance company.

In view of this rumor, the Boeing company was forced to anticipate the result of the research and expressed that they were aware of the problems caused by defective loading hatches and that they had asked all airline companies to furnish them with additional steel lockers, which they did.

In turn, and in connection with defective loading hatches, the NTSB's (National Transport Security Board) spokesman said that after examining the remains of the plane, they had decided to eliminate this as a possible reason.

2.4.2.1 The "Friendly Missile" Variant

Amidst all versions, the most widespread and popular rumor was that of the "friendly missile". It had different variants. Some stated that a U.S. Army missile ship -sailing in the Atlantic in the area known as W-105- had released a missile by mistake, thus reaching the plane. According to the rumor, the source belonged to an unidentified former safety

chairman from the Airline Pilots Association. W-105 is a dangerous area in the Southeast coast of Long Island used by the Army for shooting and missile release training.
Another variant of the rumor is that the missile had been released from a portable system on earth; another said that a Stinger missile had been released from a National Guard helicopter. It is worth mentioning that a helicopter's maximum flight altitude is 500 meters; in addition, experts explain that Stinger missiles –repetitively mentioned by rumors- cannot shoot down a plane at a 10,000 feet distance (3,000 meters), since it is not within their scope.
Of course, in all cases, rumors expressed that the American Administration was deliberately hiding the issue and that the intention was to confuse the public opinion to cover the incident.

2.4.1 Brief Classification of Rumor Variants

According to a simplified classification, TWA 800 Flight rumors can be basically classified in five groups from the point of view of the argument:

- The enemy missile theory
- The friendly missile theory
- The bomb theory
- The defective hatch theory
- The UFO theory

Three months after the incident, rumors developed in the following sequence (Web page versions are included; those versions from messages in newsgroups, e-mail listings and comments in chats are excluded since they leave no trace):

Date	Source (Web page)	Title	Plot
July 19	UFO Roundup	TWA 800 Flight – the UFO connection	The same plane had already gone through an incident with UFOs in 1976 when it belonged to Iran. A witness saw a UFO in the direction of the plane 4 days before the incident.
July 21	Rumor Mills News Service	A Stinger missile shot down the TWA 800 Flight. The attack is self-attributed by an Islamic terrorist group.	A Stinger missile released from a boat by Arabian terrorists destroyed the TWA 747 at 13,200 feet of altitude.
July 21	Rumor Mills News Service	Update: 4 new Stinger missiles aim at the U.S.	RM News has discovered that 4 Stinger missiles as the one that shot down TWA 800, owned by Islamic terrorists are aiming at U.S. targets.
July 22	Clark Matthews	TWA 800. 100	More than 100 witnesses attest

		witnesses report a missile-type object.	of a missile-type object impacting from behind the TWA Boeing 747 with horizontal trajectory
July 23	Orlin Grabbe	TWA Flight 800	An earth-air missile shoots TWA 800 down. According to military sources, other 200 Stinger missiles are missing from the U.S. Armed Force
July 23	Emergency Net News Service- ENN	How could a missile shoot down TWA 800 Flight	The missile attack to TWA Boeing 747 may be attributed to the Hezbollah movement.
July 24	Sherman H. Skolnick	TWA 800 and CIA	The CIA supplied the terrorists with the missile later used to shoot down a U.S plane.
July 28	UFO Roundup	Update on the 800 Flight Fall. Unusual suspects.	A spy satellite has photographed a UFO flying around the TWA flight.
July 28	J. Orlin Grabbe	Syria and TWA 800	A Syrian terrorist group might have given the alert on the TWA 800 affair.
August 24	J. Orlin Grabbe	Clinton's "Choo-choo"	Clinton preferred to take the train to Kentucky because he feared a plane attack similar to TWA's.
August 25	Nando.net	Terrorists illegally bring missiles into U.S.	Islamic terrorists smuggled air-earth Stinger missiles from Pakistan 7 months ago. One of them shot down TWA 800.
August 26	New York Times	A snapshot gives a possible clue on the explosion	The snapshot shows a cylinder-shaped object with an ignited end, similar to a missile.
August 28	USA Today	A photo renews the theory that a missile shot down Boeing 747.	A light signal in the photo taken by a witness in a Long Island restaurant shows an object that could well be a missile.
October 13	Nando.net, N.Y. Times News Service	Pros and cons of the theories on the TWA explosion.	It analyzes the arguments for and against the bomb, missile and the mechanical failure theories.

Besides these extracts of rumors spread on the Internet, there are those spread through formal channels of communication based on the information obtained in the Web.
As said before, the media usually deny the fact that they resort to the Internet to obtain news. However, it has been proven that they do. The anxiety to be ahead of their competitors seduces radio and television stations and the press many times to resort to the WWW without proving the truthfulness of the data. Pierre Salinger, a well-respected U.S. reporter and former President Kennedy's advisor, shocked the world with the

announcement before French officials that he possessed "irrefutable" evidence that the TWA tragic accident had been caused by a bomb. According to Salinger, the information had been given to him by a French intelligence agent. Later he was forced to admit that the data belonged to a document available placed on the Internet by an alleged "leading investigator in aeronautic matters". His "irrefutable evidence" had been nothing but a simple rumor.

Sixteen months after the plane explosion, the FBI publicly -and unusually- explained how they got to be convinced that the tragedy was not originated by a sabotage. The key element of their argument was a computerized video recording of the accident generated by the CIA. Intelligence agents recorded reports of 244 witnesses who declared they had seen lights before the plane sank in the Atlantic Ocean. They added the known information about the flight: altitude, speed and direction (the location had been continuously recorded by radar along 12 spots in the East coast and a satellite had captured the second explosion that looked like a fireball). Back up by the video, the director of the New York FBI office said that the decision to suspend the investigation was based on the absence of evidence indicating a crime; he added that the public explanation was essential to put an end to conspiracy theories. He also expressed that the people who thought to have seen a missile, actually saw the different stages of the plane explosion. After the first explosion - that detached the cockpit and fuselage - the rear part of the plane, on fire, went upwards; this is what gave the impression to the witnesses that there was a missile going up in the sky. Although the CIA's video only gave a simulacrum of the facts, it was the dramatic epilog of the criminal investigation conducted by the U.S. administration; it reported the details of the plane accident, from the initial explosion to its impact on the ocean after some seconds. The video recording described three different explosions, which according to Kallstrom, helped explain the witnesses' accounts.

Reconstruction of the crashed TWA 800 plane

It was finally known by the spring of 1998: after detailed analysis of the remains of the plane removed from the ocean and reconstructed with endless patience (photo), the effort to resort to all the tools available in order to kill the rumor.

Security Bureau determined that a short-circuit -resulting from a defective insulation of an electrical conduit inside one of the fuel tanks- had originated the tragic accident. When this news was spread via all the worldwide media, nobody remembered the rumors but for the researchers.

2.4.3 Synthesis

As in the previous case, this one fits perfectly within the Conspiracy Theory, to be described in chapter four. The number of rumor variants is interesting. This leads to the conclusion that when the first information of such a relevant events for the public is fast spread, it is difficult for feedback processes of communication to fit the rumor content into one variant or else avoid its deformation. Here, several variants have obviously appeared from the start (UFO, the defective hatch, the bomb and the missile); it can be seen that in the case of the missile there was a deformation from the “enemy missile” to the “friendly missile“. Finally, and in opposition to the case of Lady DI, the U.S. authorities made a big

Third Part: Complexity Theory and Chaos. The New Scientific Paradigm

“Chaos of thought and passion, all confus'd;
Still by himself abus'd, or disabus'd;
Created half to rise, and half to fall;
Great lord of all things, yet a prey to all;
Sole judge of truth, in endless error hurl'd:
The glory, jest, and riddle of the world!”
Alexander Pope

3 Complexity Theory and Chaos

3.1 Introduction

As in the case of physics, the complexity and chaos theories provide the foundation to approach the study of all the other scientific disciplines. In this sense, it constitutes a tool box of methods that allow the incorporation of non-linear dynamics into the study of science. In fact, attempts to classify the discipline separately from other sciences have been -and still are- resisted. For many, the study of complexity represents a (re-) unification of all sciences.

Complexity theory and its related tools as well as the chaos theory have developed on the basis of three scientific fields: mathematics, physics and biology.
Mathematics applied to the study of complex systems started to be developed 100 years ago by the French mathematician Henry Poincare[1] based on the use of strange attractors, fractals, automata and other graphic mathematical models (non linear) in the study of stochastic processes (sequence of reciprocally conditioned stages).
In the field of physics, the study of complexity started mainly as from the study of thermodynamics and turbulence. This brought about an understanding of self-organizing systems and the state of systems (equilibrium, quasi-equilibrium, edge of chaos and chaotic). According to Prigogine, the concept of entropy "the pass from a state of predictable order to a state of random disorder" is actually the physicists' application of the concept of evolution to physical systems, since the greater the entropy of a system, the more developed the system is[2].

The complexity and chaos theories have caused a strong impact, especially on quantum physics in its attempt to reconcile quantum chaos and the predictability of the Newtonian universe. This unification has been mainly driven by Einstein himself. However, it is also the complexity theory that has made most physicists accept what Einstein had refused to accept: that, when creating the universe, God did actually play dice[3].

In the field of biology, the study of complex systems allowed for the identification of new evolutionary processes that lead to understand the genetic algorithm, to simulations of artificial life and to the understanding of learning processes in systems, including the brain. In this way, as the study of the Chaos Theory goes forward, the differences between these sciences are disappearing. For example, fractal research is now employed in biological studies and to understand the information needed to design computer and

(Many of the notes correspond to texts in Spanish. English versions of those texts are most likely available)

[1] On the works of the great French Mathematician see: Henri Poincaré, *Science et Méthode* (París, Flammarion, 1908).
Also on the GSP (Great Systems of Poincaré), see: T. Petrosky and I. Prigogine, "Alternative Formulations of Classical and Quantum Dynamics for Non-Integrable Systems", *Physica (*175 A, 1991, page 156).

[2] Ilyia Prigogine, *Las Leyes del Caos*, (Barcelona, Crítica, 1997), page 107.

[3] Ilyia Prigogine and Isabelle Stengers, *La Nueva Alianza – Metamorphosis of the Science*, (Spanish edition: Madrid, Alianza Editorial, 1994), page 277

telecommunication networks; genetic algorithms are applied in economic research and stock exchange forecasts.
The key question is whether the present research and academic structure will support this incipient movement proposed by the study of complexity as the way to the unified scientific research.
Some years ago, most scientists would have strongly refused to incorporate the term "chaos" into their technical vocabulary. Up until then the prevailing concept was the 17th century vision of the world, formulated by the French mathematician Laplace, by which the development of all things is predictable as long as all initial conditions are known. He wrote: "The present condition of the Nature system is obviously a consequence of its previous condition and if we imagine an Intelligence that for an instant could know all the relations between the parts of the Universe, it could predict places, movements and the general relations among all these parts for all the moments, both past and future." [4] This statement, called by many "*the Laplace demon*", in reference to above mentioned Intelligence, constituted one of the main foundations for the scientific work that would still influence science to date. It seemed possible to explain the most complex phenomena, since it was just necessary to know all the variables. John Stewart Mill wrote: "The order of nature, as perceived at first sight, shows chaos followed by chaos at every time. We should disassemble each of these instances of chaos into individual facts. We should learn that the chaotic antecedent is a multitude of a diversity of antecedents, and the chaotic consequence is a multitude of a diversity of consequences"[5].

Chaos theory is great as a way of looking into the facts occurring in the world in a different way to the most traditional and strictly deterministic vision that has dominated sciences since Newton. In fact, it proves useful if taken as a tool to interpret the scientific data in a new way. Instead of employing bi-dimensional matrix coordinate charts, scientists can now interpret phase-space diagrams that -besides describing the precise position of a system's variables at a certain moment- represent the general system's behavior in or throughout time. Dynamical equation systems have also been used to mould population growth to epidemics or heart arrhythmic thumbing. In fact, almost any chaotic system can be shaped: the stock exchange provides trends that can be analyzed more rapidly from strange attractors than from explicit traditional equations.
A dripping tap may sound accidental to the untrained ear; but when designed as a strange attractor, it reveals an unexpected mysterious order.
Today many define Chaos Theory as Complex and Dynamical Non linear Systems Theory, Complex Systems Theory, Complexity Theory or Dynamical Systems Theory. We owe the use of the term *Chaos Theory* to James Gleick, a Harvard graduate in journalism who worked as a journalist and editor for the *New York Times* for ten years. In 1987 he wrote *Chaos: Making a New Science*, a book that still today continues to be a must for those who approach the issue for the first time[6].

[4] Pierre Simón Laplace, *Analytical Theory of Probabilities*, cited by Moisés J. Sametband, *Between Order and Chaos: Complexity*, (Spanish edition: Buenos Aires, Fondo de Cultura Económica de Argentina, Asociación Ciencia Hoy, 1994), page 24.

[5] Robin Robertson and Alan Combs (editors), *Chaos Theory in Psychology and the Life Sciences*, (New Jersey, Lawrence Erlbaum Associates, Inc., 1995), chapter 1.

[6] James Gleick, *Chaos, Making a New Science,* (New York, Penguin Books, 1987).

Despite what we were taught before, the fact is that chaos and order are not opposites, one is good and one is bad, from which we have to choose. In fact, they are two inseparably joint sides of the same coin of reality. Chaos Theory is a conceptual tool, similar to a powerful lens that enables us to see both sides and thus delve into the works of our incredibly complex and mysterious cosmos and micro cosmos. “In old times, the mirror-worlds of chaos and human order lived in a precarious alliance, but science changed all that. The arrival of science, more specifically the reductionist science, brought about a powerful spell and for years the chaos mirror-world was suppressed”[7].

One of the ways in which the early Greek philosophy “improved” the mythical idea of disorder was by injecting a scientific attitude. According to Thales, Anaximander and Anaxagoras, a specific substance or energy -water or air- had been present in a chaotic flow and such substance had originated the various forms of the universe. They thought that disorder would eventually dissolve and return to the cosmic flow and then a new universe would emerge.

Aristotle took the scientific approach a step beyond and he furthered the distance from chaos. He believed that order comprises everything and that it exists in increasingly subtle and complex hierarchies. Medieval and Renaissance thinkers turned this concept into the Great Chain of Being, a scheme that comprised all forms of life, from worms to angels, in an ascending scale.

The Middle Ages were changing times when the Greek scientific spirit of Aristotle, Euclid, Democritus, Pythagoras and Hippocrates fought against old mythologies. Medieval hermetists and alchemists exemplify this conflict. They mixed Gnosticism, Christianism and theologies from Egypt, Babylon and Persia. They believed in creation deriving from pre-existent chaos that included the grotesque and the irrational. They thought that mutability, darkness and mire generated life, that descending to chaos and encounters with monsters brought along vitality, that creation was a process of constant renewal. As the astrologists, they stated that “it is above as below”. But alchemists were scientists working with scientific instruments and methods and they contributed with important chemical discoveries.

In times of Galileo, Kepler, Descartes and Newton, the scientific spirit and chaos suppression prevailed. The Newtonian laws of astronomic mechanics and Cartesian coordinates (that enabled scientists to approach the universe as if it were a huge diagram) created the impression that everything could be described in mathematical or mechanical terms.

Under Napoleon I’s rule, the French physician Pierre Laplace reasonably imagined that scientists would one day work out a mathematical equation so powerful that it would explain it all.

Thus, our habitual vision of the world is expressed through a metaphor gathered by the Western world collective imaginary in the early 17th century, almost 400 years ago! From Descartes’ famous phrase “universe with clockwork precision” to describe his observations of the world, we have conceived our organisms as precision machines, subject to the control of some clockmaker. Why? Because the western theological and philosophical thinking has been built around the notion of avoiding and controlling chaos, thus continuing the act of creation, i.e. the act of creating order out of the disorder in the universe. From this point of view, chaos was merely such a vast complexity that in practice scientists could

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[7] J. Briggs and F.D. Peat, *Turbulent Mirror: an Illustrated Guide to Chaos Theory and the Sciences of Wholeness*, (New York, Harper and Row, 1989).page 21.

not figure it out, although they were sure that they would manage to do so some day. That day chaos would exist no longer.

In the 1870's, the Viennese physicist Ludwig Boltzmann tried to neutralize the second principle of thermodynamics, which states that, as they get increasingly complex, systems tend to a state of disorganization and chaos. This trend is known as entropy or entropy mechanics. One hundred years later, as will be seen, it would be demonstrated that this principle does not hold valid for all systems. Some tend towards order instead of disorder.
Boltzmann wanted to show that Newtonian mechanics was still universally true, but only at the reductionist level of atoms and molecules. The movement of these parts of the cosmic clock was always subjected to Newton's laws, but within a complex system, where billion of atoms and molecules rotate and collide with each other, an orderly relationship between them is less likely to occur. In the huge scheme of all elements, the orderly arrangement of large clusters of atoms and molecules is highly improbable, Boltzmann said. Therefore, it is not surprising that when those orderly relationships do occur, they collapse relatively fast. Boltzmann purported that eventually even the atomic structure of the solar system would collapse into randomness. By introducing *likelihood* in physics, he prevented chaos from corrupting reductionism, since he demonstrated that the passive chaos of thermal entropy was just an expression of Newtonian order.
While Boltzmann showed the mechanics of entropy, Charles Darwin announced a theory that explained the appearance of new ways of life. Like Boltzmann, he understood that randomness was a key factor in the mechanistic processes that ruled complex forms. But here randomness, instead of altering the complex order and destroying it, caused variations in individuals of the existent species. Some of these variations would survive and lead to new species.

In the 19th century, when building bridges, steam vessels and other technological wonders, engineers usually came across disorder and were confronted with abrupt changes that did not resemble the slow growth of entropy as described by Boltzmann and the science of thermodynamics. Plates got curved and materials fractured. These phenomena posed a challenge for the powerful mathematics that the Newtonian revolution had forged.

For science, a phenomenon is orderly if its movements can be explained throughout a cause and effect scheme represented by a differential equation. Newton introduced the idea of differentiability with his famous motion laws, which connected the reasons for change with different forces. Soon scientists decided to resort to linear differential equations. These equations enable the description of various phenomena such as the trajectory of a cannon ball, the growth of a plant, carbon combustion and the performance of a machine, where small changes produce small effects and great effects are obtained through the sum of several small changes[8].

Although the metaphor of the machine has been abandoned by the 20th century science, most of us keep on embracing the soothing image of clockwork precise systems. However, nowadays scientists from new fields of study such as quantum physics, environmental ecology and biogenetics, among others, have conclusively demonstrated that the universe is like a huge living organism rather than a mechanical gadget. Today, while the "old science" rooted in the Cartesian metaphor is being left aside, the portion of the world it is

[8] J. Briggs and F.D. Peat, *op.cit.,* page 21 -23.

still applied to is nothing but a chip within the whole. We are not a piece of a clock but integral growing and changing participants of a living whole.

We all know that the world we live in is complex, and the short reach of predictions on the economy of a country, the weather forecast or the behavior of any human being or living organisms in general surprises nobody. This has always been understood as indicating that if there are laws for this complex world, they are to be complex as opposed to those ruling dynamical systems studied by physics, i.e. orderly and predictable. But now even simple physical phenomena, subject to simple laws can show a chaotic and unpredictable behavior.
When scientists realized that their mathematical models based on linear equations were no longer sufficient, they started to develop a different type of equations: non linear equations. These non-linear equations are specifically applied to discontinued things such as explosions, sudden material cracking and high winds.
The problem with these equations, vaguely known to scientists in the 19th century, was the need for knowledge of mathematical techniques and forms of intuition not accessible by then. They could only solve the simplest non-linear equations in special cases. Thus, the general behavior of non-linearity was surrounded by mystery.
Luckily, it was not necessary for 19th century engineers to penetrate this mystery to perform their mechanical feats since for most of the critical situations they encountered they could resort to *linear approximations*. Linear approximations are a version of differential equations. They depend on familiar intuitions and the proven and reliable reductionist links between cause and effect. These equations were a trick that masked the abrupt shapes of chaos. The arrival of high-speed computers in the 70's and the advances in mathematics allowed scientists to probe the complexity inside non-linear equations. Consequently, in a few years this peculiar mathematics became one of the winds that drove the "science of turbulence": the barrier had been broken.

3.2 General Theory of Systems (GTS)

To understand complex systems, it is first important to analyze the meaning of a system and the General Theory of Systems[9]. According to several scientists today, the General Theory of Systems is not a very good one. They criticize the fact that "there is actually no *general* theory of systems". However, the current scientific application of this theory is far from being a failure[10]. Among its successes we can include Bateson's psychological theories[11], Ashby's works on cybernetics[12], McCulloch's research on neural networks[13] and other ideas in the field of operational research, among others.

[9] Ludwig von Bertalanffy, *General Theory of Systems*, (Spanish edition: México D.F., Fondo de Cultura Económica, 1995).

[10] "After the failure of logical positivism and the mechanistic approaches to science, there is just one approach that has seriously claimed it could restore the idea of integration: The General Theory of Systems". (Ludwig von Bertalanffy, 1968).

[11] Gregory Bateson, "Cybernetics and Systems Thinkers", (Principia Cybernetica Web – ©, http://pespmcl.vub.ac.be/CSTHINK.hmtl , October 1997)

[12] W.R. Ashby, *An introduction to Cybernetics*, (New York, John Wiley & Sons, 3rd ed. 1968)

What does the modern science of complex systems have that GTS does not? The answer is simple: the power of computer processing.

In the intent to fathom the depths of the order of things and organisms, scientists were historically presented with two basic ideas that had proven successful. One of them *compared organisms to machines created by men*. The theory of living organisms as clockwork machinery (18th century) and caloric, chemo-dynamical and cybernetic machines (this century), explained the biological phenomena from the general viewpoint of physiology of organs to sub-micrometric structures.

The other basic idea was *the conception of order as result of probability*, expressed in the Darwinian idea of natural selection. This dispute over the conception of organism, staged in the first decades of this century, evolved into a growing doubt about the foundation of the paradigm of classical science, i.e. the explanation of complex phenomena in terms of isolated elements. This is related to the above mentioned concept by John Stuart Mill, in connection with the break-down of individual facts in successive instances of chaos.

Mill's statements show a key axiomatic aspect of the classical mechanistic view of the world: the breaking of complex systems into subsystems and sub-subsystems to the point they are liable of being analytically grasped; then with the subsequent summation of subsystems, the understanding of the overall system becomes possible. This methodological artifice was manifested in various sciences up to date. One of the numerous examples of this manifestation could be the partial analysis introduced by A. Marshall in the economic theory. The possibility of breaking systems down to later reassemble them generated a pairing of the different subsystems determined by their linear nature. In this way, a vision of the world in which the whole was understood as the sum of its parts was established in the sciences.

By the end of the 30's, the Canadian biologist and philosopher Ludwig von Bertalanffy, born in Austria (1901-1972), started to develop his general theory of systems. He stated it in the way: "Since the nature of the living matter is its organization, the research of processes and elements is unable to offer a complete explanation of the vital phenomena. The point is then researching the laws of organized living systems. Now, if we replace the term "living matter" with "organized entity", we obtain a methodology that will allow the study the laws shared by all sets of entities, as an organization." In this way, Bertalanffy's statement went beyond a theory and became a paradigm to develop theories[14].

One decade ago he had stated that "the property and action pattern of superior organized entities cannot be explained by the sum of their properties and action patterns of their components if taken in isolation. If we assembled the components and we established the existing relations among them, the superior level would derive from these components."
This means that in order to understand an organized whole, we should know both things: the parts and the relationships among them. In this sense, a system is an entity that maintains its existence and works as a whole through the interaction of its parts. Its

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[13] Warren McCulloch, "Cybernetics and Systems Thinkers", (Principia Cybernetica Web – ©, http://pespmcl.vub.ac.be/CSTHINK.hmtl , October 1997)

[14] Ludwig von Bertalanffy, *op. cit.*

opposite is reductionism: the idea that something is simply the sum of its parts. A collection of unconnected parts is not a system[15]. The difference is clearly seen in the following chart:

System	Collection of parts
Interconnecting parts functioning as a whole.	A collection of parts.
It changes if pieces are taken out or added. If a system is cut in half, you do not get two smaller systems, you get a damaged system that will probably not work.	Essential properties unchanged whether parts are added or taken away. When you halve a collection of parts, you get two smaller sets.
The arrangement of the pieces is crucial.	The arrangement of the pieces is irrelevant.
The parts are connected and work together.	The parts are not connected and can function separately.
Its behavior depends on the total structure. Change the structure and the behavior changes.	Its behavior (if any) depends on the size of the collection, or the number of pieces in the collection.

In this sense, a system can be defined as the understanding of the relation of its interacting parts. For example, a heap of stones is a system that interacts depending on how they pile up. If they are not piled up in equilibrium, interaction would provoke its movement until equilibrium was restored. A set of stones that do not touch each other does not constitute a system since there is no interaction (technically there is interaction due to the gravity force, but since it is so slow, it is not deemed an interesting topic of study and the meaningless existing interaction is ignored).
A system can also be modeled. That is, another system can be created, a model that is supposed to repeat the behavior of the original system. Theoretically, we can take a second set of stones of the same shape, weight and density as the original system, pile them up as the original set and predict that they are to fall following the same configuration of the first group. Or you can resort to the mathematical representation of the stones - through the application of Newton's gravity law- to predict the interaction of future piles of the same and different types. The mathematical model is key but it is not the only process to establish a model of systems.

If instead of analyzing the parts of a system individually, you observe the connecting pattern, there emerges an interesting fact: systems created as from very different parts, with different functions, follow the same organization laws. Their behavior does not depend on what the parts are like but on how they are interconnected. Therefore, prediction is possible without knowing the parts in detail.

The human body and the family are systems. We live in a huge complex natural system, we build towns and cities that operate like systems. There are mechanical systems such as computers, cars or automated factories. We speak about political, economic and belief systems. Each of them operates as a complete whole that combines several separate

[15] On this topic see: Joseph O'Connor and Ian McDermott, *The Art of Systems Thinking : Essential Skills for Creativity and Problem Solving*. 1997.

parts. Whether they work well or not is another matter. Systems can be simple, i.e. the heating thermostat in our homes or very complex, such as the weather.

A system in itself can be part of a larger system. In the human body we have the digestive system, the immune system, the nervous system and the blood system. You can study any of these in isolation, and also how they all work together in the total system of the human body. Likewise, a car is a mechanical system made up of different subsystems like the cooling system, the electric system and the fuel system. All these systems work together to produce the smoothly working car that will take you where you want to go. You do not bother to think about the smaller systems until the car breaks down and then you discover why reductionism is so frustrating: you have all the bits of the car but they are not interacting. It is basically a heap of scrap metal. A mechanic would need to look at the different subsystems inside the car to determine what had gone wrong and fix it.

In the world of GTS, bigger does not mean better, but worse. Each system has an optimum size, below which it starts to grind to a halt; above it, it grows out of control. For example, as a business grows, it turns harder to manage: a team of six people may work well; a team of six hundred would be unable to work unless they were divided into smaller groups. This growing complexity, as will be seen later, has an effect known as entropy.

3.2.1 Non linearity

The first thing to know about non-linearity is that, despite its confusing name, it is a simple concept. Technically, a non linear system is any system where the input is not proportional to the output, i.e. an increase of x does not carry a proportional increase or decrease of y. A simple example of a non linear system is the system related to headaches. If you have a headache and take an aspirin, the headache will be reduced in a certain proportion. If you take two aspirins, the reduction will be higher. But it is obvious that 64 tablets of aspirin will not reduce the headache 64 times more than a single one. A headache is, thus, a non-linear system. Non linearity is simply that.
Another example: we predict that if we add a certain number of staff members or inventory, we will increase production proportionally. In this sense, the input would tell us the output. However, managers know that factories do not work like this. If the number of staff members, inventory, etc. is modified, different results will be obtained daily compared to the original prediction. This is because a factory is actually a non-linear system.

Secondly, it is necessary to know that non-linearity, from a linear perspective, has a paradoxical nature. The first position of the human thinking is linear. In linear thinking, if something is good, it is better to have the most of it; if something has a negative effect, the least the better. And while this is a reasonable departure point, we learn that the world is much subtler than that. The existence of non-linear models implies the growth of a more subtle and therefore, more realistic vision of the world. For example, the non-linear model has helped engineers understand why a new road sometimes originates traffic jams. This and other similarly opposing phenomena have been observed; however, they seem to defy logic, laws and reason.
Non linear models represent this apparently abnormal and illogical behavior which in fact is not so. On the contrary, they make every behavior more concrete and consequently, more reasonable. These models turn non-linear behavior into a logical one.

Finally, it is necessary to know that it is virtually impossible to categorize non-linearity as a whole for each type of effect. Non linearity is just the opposite; it produces positive (amplifier) or negative (reducing) feedback; stability or instability; coherence (for example, convergence, union or cohesion), but also divergence and explosion. The key to understand non-linearity is that, as opposed to linear systems, contrasting tendencies can be created in a single system. This means that the world of non-linearity is extremely versatile.

It is important to realize that everything is basically non-linear, and that non-linearity has an off the line behavior potential regarding linear expectations. Here is when we understand how the classic science may have lost some elements that are now being explored, without even reaching chaos itself. Until access to the computing power was possible, science could only see the tip of the iceberg of the non-linear world because there was no access to the world's subtlety. The point with this scientific revolution is that, when knowledge is broadened through an approach to the non-linear world, there is a totally different vision on how the world works. However, there is another critical concept for the non-linear revolution: interdependence. In general, chaos popular literature confuses interdependence and non-linearity, but in fact they are not connected. Non linearity has to do with proportionality. Interdependence is about whether two things are mutually affected or not (or, in mathematical terms, if they are functions of each other). A conversation is an interdependent communication (also called interactive) between two individuals, i.e. both people are affected and this exchange is an effective mutual and reciprocal system. Theoretically, a monologue is an independent unidirectional communication, i.e. the message is directed to the addressee exclusively. Independent systems – such as linear systems- are in fact advantageous idealizations. But in the real world there are no true linear systems and there are no true independent systems, not even monologues. The concept of totally independent systems tended to generate erroneous conclusions in reference to the world works (in contrast to our models). It is evident that the devil is in non-linearity[16].

Interdependence is important because it is a critical part of chaos and construction of order. The most revolutionary non-linear concepts come from non-linear interdependent systems. For example, the phenomenon of chaos itself (due to its sensitive dependence to initial system conditions, as seen later) occurs exclusively in non-linear interdependent systems. Non linearity alone is not enough. The non-linear revolution is about the exploration of the nature of non-linear interdependence that, in the final analysis, constitutes all systems of the real world.

The solution to a differential equation is called integration: the most important class among integral equations is that of linear equations. The simplest one among these equations depends on a single variable and its solution is graphically represented by a straight line,

[16] Stein concludes that "Since no two individuals, by virtue of their non-identical initial conditions and history (sensitivity to initial conditions), can experience the same reality, we cannot get into each other's heads – empathy is at best a wish, at worse, a delusion – counter-transference is ubiquitous. Differential equations and rules derived from them cannot describe universal developmental trajectories – the evil is in the non-linearity." (Stein, A.H., *The Self-Organizing Psyche: Nonlinear and Neurobiological Contributions to Psychoanalysis*. In: Sulis, W.Y.Combs, A. (edits.): *Studies of Non-linear Phenomena in Life Sciences* – Vol. 5: *Nonlinear Dynamics in Human Behavior*. World Scientific. New Jersey, 1996. page 272)

therefore its name of linear equation. The characteristic of the family of linear equations is that their solutions for various numeric values of the variables can be added up, in turn originating a new solution. A simple example is the linear wave equation that describes the movement of small magnitude waves along a liquid surface. The equation has several different solutions, each with different wave amplitude and length; they can be added to make up a new solution to the equation. This expresses, from the mathematical viewpoint, the physics fact of how different overlapping waves can be viewed on a lake. This overlapping corresponds to the solution that is the sum of solutions of the wave linear equation.

In general, linear equations are much easier to solve than non-linear ones; therefore, they have been the object of more studies. When building the mathematical models of nature systems and representing them on a chart, we realize that their mathematical representations do not produce straight lines and that the results of the system are not easily predictable. In the non-linear world –that involves most of our real world- *accurate* prediction is practically and theoretically impossible.

Most of the scientific studies prior to the development of the complexity science aimed at the comprehension of the world using linear models. Starting with Isaac Newton's works, physics has contributed the process for modeling nature and the mathematical developments associated have been linear. When the answers about the result of a research were weird or when a prediction did not prove true, the failure was said to derive from an experimental error or from *noise* in the system; or else, when a physical phenomenon was to be expressed through a non linear equation hard to solve, the usual procedure was to "linearize" it by eliminating the terms with the least influence, i.e. a linear approximation was introduced.

At present, through the research of the complex system theory, it is known that noise constitutes important data for the experiment. When noise is added to the results of a chart, the result is no longer a straight line, nor is it predictable. This noise is what in the experiment was originally known as chaos. It was because of the study of this noise, this chaos, that was one of the main concerns of the researchers of the complex systems theory, that Gleick originally called this discipline "Chaos Theory".

3.2.2 Feedback

Feedback is one of the differences between linear and non-linear equations, i.e. non-linear equations' terms repeatedly multiply by themselves. This process is also known as iteration.

One example of feedback is the thermostat switched regulator controlling a household heating system. A room gets colder and the temperature reaches a lower preset limit. The thermostat reacts and activates the heating that will later warm the house. When the average temperature exceeds a second preset temperature, the thermostat deactivates the heating system. The actions of the thermostat and heating system are connected to what is technically known as negative feedback loops. In the 50's, scientists realized that negative feedback was not the only type; there is also positive feedback.

The deafening screeching of a loudspeaker system is an example of positive feedback, activated when a microphone is too close to the loudspeaker. The outgoing sound from the amplifier is caught by the microphone and sent back to the amplifier to be emitted by the

loudspeakers. The chaotic sound results from an amplifying process in which the results of one phase feed another one.
“Negative” and “positive” feedback does not imply judgement. These labels only indicate that one type of feedback regulates while the other amplifies. Today it is an acknowledged fact that the two basic types of feedback are everywhere: in all the levels of living systems, in the evolution of ecology, in social interaction and in non linear equations’ mathematical terms. Feedback, as well as non-linearity, embodies an essential tension between order and chaos[17].

In the field of social communication, feedback is an essential factor. When an individual A tries to send information to another individual B, A’s sensory system is not enough to be an adequate data source unless B acts in such a way as to help A keep updated on his own progress. If A tried to reach B with a stone, A’s eyes -combined with a motionless B- may be adequate for A to hit the target after several attempts. But if A tried to reach B with data, success would probably be achieved if B helped A through clues that A’s sensory system cannot directly perceive. In other words, feedback –such as verbal language or gestures- assures a more efficient process when the target is communication between A and B. In this sense, A’s or B’s feedback increases B’s certainty of receiving the desired information and A’s certainty of transmitting it. This increase in certainty, assuming there is motivation of those involved in the communication process, somehow impacts the feelings of frustration or achievement and thus it has an effect on the feelings of hostility or confidence attached to the relation.
Negative feedback characterizes homeostasis (constant condition); it therefore plays a major role in the achievement of stability of relations. In turn, positive feedback derives in change, i.e. the loss of stability or equilibrium in the relationships of the interacting participants. In both cases, part of the output of a system goes back into the system as information about such output. The difference lies in that, in negative feedback, this information is used to lower –hence the use of the adjective “negative”- the deviation of the output regarding the established standard, while in positive feedback, the information acts as a way to increase output deviation; it is “positive” regarding the existing tendency towards motionlessness or disorganization. Social systems can be understood as feedback circuits whenever an individual behavior affects the behavior of others and is in turn affected by them. The system’s input can be amplified and become change or find a counterpart to maintain stability, depending on whether the feedback mechanisms are positive or negative.[18]
In communication processes, feedback is an error correction mechanism able to overcome the noise of the system; it therefore improves message transmission accuracy. On the other hand, as was said before, redundancy is the iteration of a signal that also aids in overcoming noise. Thus, feedback and redundancy are (mutually) related because they maintain the stability and equilibrium of the system.

[17] J. Briggs and F.D. Peat, *op.cit.*, page 24 -26.

[18] Paul Watzlawick, Janet Beavin Bavelas and Don. D. Jackson, *Theory of Human Communication*. (Spanish edition: Barcelona, Herder, 1991).

3.2.3 Emerging Properties

Systems as whole entities show properties above and below their constituent parts. These are known as emerging properties because they “emerge” from the system when it is operating. Imagine one hundred pictures of Mickey Mouse with slight differences. It is not very appealing. Now run them quickly one after another and Mickey seems to move. It is a “cartoon”, not just a set of still Mickey pictures. When the different figures form a smooth progression, the movement is also smooth; this is an emerging property. Emerging properties are unpredictable, in general sudden and at times surprising.
Emergents come from systems as those three dimensional pictures that pop out from the random swathes of colored patterns in the infuriating and attractive ‘Magic Eye’ books, if you stare at them with the right focus from the right distance. There is no way you can predict the picture from the colored pattern you immerse yourself in.
The conscious mind itself is expressed as an emergent from the incredible complexity of the human brain. Who could have predicted that the billions of brain interconnections would allow the feeling of having self-awareness? All our senses are part of our self. We have the power to see, not our eyes. Life depends on the operation of the set of its parts. When the parts are isolated from the body they die. We cannot find sight, hearing, taste or smell in any of the parts of a body. We cannot discover or reveal the secret of life by dividing the body, in that way we only discover death.
The equilibrium in nature is an emerging property. Plants, animals and weather conditions work together to create a prosperous environment; although within this environment the specific equilibrium may be lost, and some species may die, while others may dominate but, above all, another equilibrium will emerge. Even deserts are environments with equilibrium. As the system of nature is so complex, it is very difficult to predict how it may be affected by an alteration.

When you separate a system into its parts, when it is “deconstructed”, its essential parts are nowhere to be found. These properties only emerge when the whole system is operating. The only way to discover these properties is by running the system, making it work. The positive side of these emerging properties is that their benefits are known, regardless of the understanding of the system. It is not necessary to be an expert in electronics to switch on the lights nor is it necessary to understand the car mechanism in order to drive.

As we find systems everywhere, we also find emerging properties everywhere: life, whirlpools, tornadoes, temperature, pressure, computerized graphs, emotions, music, the rainbow, culture, flames, conscience, morality, clouds, health, hunger, laughter, memory, dreams, pain and social communication are just a few examples of emerging properties.
In turn, the properties of the whole system may be surprising and unpredictable. For example, our two eyes together do not get a bigger picture but three-dimensional vision. Two ears do not give you the ability to hear twice as well, they give you the capability to hear in stereo. When the colors of the spectrum merge together, you do not get a muddy brown color, but white. We take all these “miracles” for granted, but would you have been able to predict them if you did not know about them? The complexity of natural systems produces some strange emerging properties, such as the beauty of the rainbow when the rain, the atmosphere and the angle of a sunbeam are positioned just right.

The critical property of systems is a mirror image of the emerging properties. As the system’s emerging properties are depicted by the whole system rather than by its parts,

the system loses its properties if you take it apart. When your take a piano apart, not only will you not find the sound, but it will be impossible to produce the sound until you reassemble it. Similarly, you cannot find a rainbow in the rain, or an image inside a television set. When you cut a system in half, you obtain a broken or dead system rather than two smaller systems.

Analysis is the name given to the process of dividing something into pieces to find out how it works. As seen at the beginning, it is the reductionist method, very useful for certain types of problems or in order to see how a larger system is made up of smaller subsystems. Through analysis, we gain *knowledge*. This method fails, however, when we try to understand the properties of the whole system. Synthesis is the complement of analysis, i.e. assembling the constituent parts of a system into a whole. Through synthesis, we gain *understanding*. The only way to find out how a system functions and what its emergent properties are is to run it.

3.3 Simple and Complex Systems

Normally, we automatically relate the concept of complexity to the number of different parts. This is complexity by detail. When you observe a thousand piece jigsaw, you see the complexity by detail. We often find the way to simplify, group and organize this type of details, since there is one place for each piece to fit. Computers are good to deal with this type of complexity, especially if order depends on a special sequence.

The other type of complexity is dynamic complexity. This is when the elements can relate to each other in many different ways, because each part has many different possible states, which are not necessarily alike. We will return to dynamic systems later.

New connections between parts of a system add to the complexity, and adding another piece can create many new connections. When you add a new piece, the number of connections does not increase by one. It increases exponentially. In other words, for every piece you add, you get a bigger increase than the one you got by adding the piece before that. For example, suppose you start with just two pieces, A and B; there are two possible links and pathways of influence: A on B and B on A. Now let's add another piece. Now there are three pieces: A, B and C. The number of possible connections, however, has increased to six; twelve if we allow two parts to form alliances and influence the third (e.g. A plus B influences C). You can see that it does not take many pieces to create a dynamically complex system even when the parts have only one state. We know this from experience: two people are more than twice as hard to manage than one, there is more chance for difficulty and miscommunication.

The simplest systems will have few parts that have only a few states and a few simple relationships with one another; a plumbing system or a thermostat are good examples. They have limited detail complexity and limited dynamic complexity. A complex system will have many parts or subsystems, all of which have different states that may change in response to other parts. Mapping this kind of complex system -i.e. through a computerized graph of all the states of the system along a specified period- would be like finding your way through a maze that changed itself completely depending on what direction you took

at any time. You could never go back to where you started, because your first move would change the maze.

A game of chess, which involves strategy, is a game of dynamic complexity because whenever you make a move, you alter the whole board because your move changes the relationship between the pieces.

The first lesson of system thinking is to know whether you are dealing with detail (a jigsaw) or dynamic complexity (a chess game).

Going back to our heap of stones: it seems to be a simple system even though it is not. In fact, it is a very complex system. For an accurate prediction as to which stone will fall where when the pile tumbles down in order to know its final shape, we need detailed information about the shape, weight and accurate location of the stones. If there is a slight difference between the shape of the stone in the model for prediction and the original one, the results are likely to differ from reality. Predictability will be very unlikely due to the system's high complexity.

The unpredictability generator of complex systems is what Lorenz called sensitivity to initial conditions[19], as will be seen later.

The human brain is probably the most complex structure in the known universe. Weighing between one and a half and two kilograms, it consists of over 100 trillion neurons or nerve cells, as many as stars there are in the Milky Way. The front part of the brain or cerebral cortex has over ten trillion neurons. The connections between the nerve cells are more important than the cells themselves, just as GTS thinking would suggest. A single neuron can have up to one hundred thousand inputs, and it may need to continually integrate a thousand inputs. The brain is not like a computer, but rather every nerve cell works like a small computer. The cortex has over one million trillion connections. If you counted one every second, it would take you thirty two million years to finish.
Each brain is unique, there are not two brains that are alike. We are born with all the neurons we need, but up to 70% of them will die in our first year of life. The surviving neurons form an even more complex web of connections and our brain quadruples in size. Certain connections are reinforced by use, and others wither as we learn about the world. The brain is not independent of the world, it is shaped by it. The outside system of the world moulds the inside system of our brain. The brain has the task of extracting pattern and sense from the huge flood of sensory information it receives. The very act of perception has also to make meaning of what it perceives, and so the brain in turn shapes the world as it appears to us. Interpretation emerges from sensation.
Neuroscientists have described the brain as an interconnected, decentralized, parallel processing distributed network of simultaneous waves of interactive resonance patterns. In other words, a very complex system.

Complex systems are bound together by many links, so they are usually very stable. The French phrase, 'Tout ca change, mais c'est tout la meme chose', sums it up perfectly: whatever changes also stays the same in important ways. It is easy to see why this is so. Imagine a system as a kind of web whose parts influence and connect to many others. The more parts there are, the more complex the system is in detail. The more connections

[19] Ilya Prigogine, *Las Leyes del Caos*,(Barcelona, CRÍTICA Grijalbo, 1997), page 46.

there are between the parts, and the more the parts can change state and form shifting alliances, the more dynamically complex it is. You could also make our hypothetical system represent a business, where the factors are such things as established procedures, job responsibilities, reward and appraisal systems and management styles. It could also be made to represent people in an organization, factors in an advertising campaign, different ideas in a belief system, a team, an extended family, the parts of a living organism or a political system.

Let's suppose the government is stable and all the pieces fit together so the system works. The links between the parts keep it steady. Now, imagine you want to change how the budget is calculated, but you cannot do this without taking all the other pieces it is linked to into account. Changing it will have a knock on effects on all the other parts of the system linked to it. They will resist the change because if it changes they will have to as well.
This is the problem with political reforms. The political system is very complex, and many a political career has floundered on the fact that despite their best efforts the more politicians try to change the system, the more it stays the same. New governments inherit a vast bureaucracy that is very resistant to change. Thus, the Civil Service is the personification of the resistance of a complex system to quick change (or indeed any change).

The whole system acts like a strong elastic net: when you pull one piece out of position it will stay there only for as long as you actually exert force on it. When you let go, you may be surprised and annoyed that it springs back to where it was before. When you see the piece you are trying to change as part of a system and not isolated, it is obvious how it will behave.
Complex systems are stable, they resist change because of their interconnections. A system made up of a collection of small systems is more stable than a large unit, because it allows many different checks and balances. Different political parties can gain power without the whole system of government being overthrown and can still function even when there is disagreement between different areas. Similarly, you can be ill, or part of your body may not work well, yet overall you can still function. This stability is really important, without it your body weight would fluctuate wildly, business would fail or boom erratically, and every disagreement would threaten your friendships. This stability is the positive aspect and it comes (of course) with a price. The price is that it is very hard to change such a system.

Systems can suddenly collapse when they are under pressure for a long period. They can also change suddenly if they are under the correct combination of actions. This derives from an understanding of the system and is known as principle of influence. Systems can also suddenly change because they are often discontinuous and non-continuous. A continuous system behaves in a predictable way through its state levels. For example, a car working fine at 15 km/h and at 90 km/h under adequate conditions, will surely work fine at an intermediate speed. It will not suddenly collapse at 50 km/h. Its behavior is continuous throughout the different speed levels.

Systems in living organisms and some mechanical systems such as computer programs are discontinuous. Therefore, and given the adequate circumstances, something strange may occur. The computer may break down, the person may lose his patience, and the body may get ill. The possibility for it to happen has always been there (remember the

famous Murphy's law[20]); it is just that the precise and necessary conditions had failed to occur and they did not appear in the tests because the system is too complex to control all variables in a testing situation.
Two software programs that function separately, if put together, may provoke malfunctioning of the computer; similarly, two people who work efficiently on an individual basis, may well have a lower performance when teamed up. Drugs are required to go through severe tests for a long period before they are launched. However, many drugs sometimes show side effects that may even be severe. They may react adversely in the presence of other drugs or sometimes side effects do not appear until years later. The presence of another drug or a long period (or both) make up one of the special circumstances. The more complex the system, the less you can trust sampling to predict its effects.

In *Exploring Complexity: An Introduction*, Ilya Prigogine[21] defines the complexity of a system through the complexity of the model necessary to predict the system's behavior. The more the model should resemble the original system to predict results, the more complex it considered to be. The most complex systems, such as the brain or the weather, demand an exact duplicate of themselves. Conversely, to predict how long it will take for a train to reach a city Y from X at a given speed -with no stops in between- you need a simple model. Knowing the speed of the train (km/h) and the distance (km) is enough (the formula is km x h/ km).

The general rule for complex systems is that it is impossible to create a model that can forecast precise results. However, we can create models that simulate the process that systems will go through.

3.3.1 Dynamical Systems

As we said before, we often take for granted that the smaller the number of parts, the simpler the system, as regards controlling and understanding it. This is not necessarily correct. A good example is the family. It can be integrated by a limited number of individuals (parts), but the mood of each of them can constantly change and therefore their relationships can vary.
A system can have few parts but a high level of dynamic complexity. Thus, problems that appear to be simple may show a great deal of complexity when analyzed.

Dynamics is a branch of mathematics. Sciences borrow the approach as a strategy to observe and model the behavior of complex sets of interconnected phenomena. As modeling company, the approach of dynamical systems measures the different aspects of such phenomena (observable variables) and formulates rules for the way these variables change in each state of the system. It is usually performed via differential equations and computerized graphs. Of course, the hypothetical variables can be used in the models.

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[20] Murphy's law: "Anything that can go wrong, will". *Murphy's Laws* (New York, Penguin Putman Inc., 1999.

[21] Ilya Prigogine and Gregoris Nicolis, *Exploring Complexity: An Introduction*. (W. H. Freeman & Co, 1989).

A dynamic system is defined by a vector field of the system's tendency to change in each state. Then the system proceeds through a succession of states after specifying a given initial state. The resulting path is called trajectory. The group of all trajectories is called phase portrait.
Dynamical systems can change and they do so when a parameter, a constant, a characteristic of the system different from the main variables is modified. That is, the equations shaping the system remain the same, but the value of a constant in the equation changes and becomes inconstant.
A parameter can change throughout a long series of values as the phase portrait changes, although it is gradual. On the other hand, a small magnitude of the control parameter value may change. In this case, there is a radical transformation in the system's behavior, called bifurcation, and it will be analyzed later.

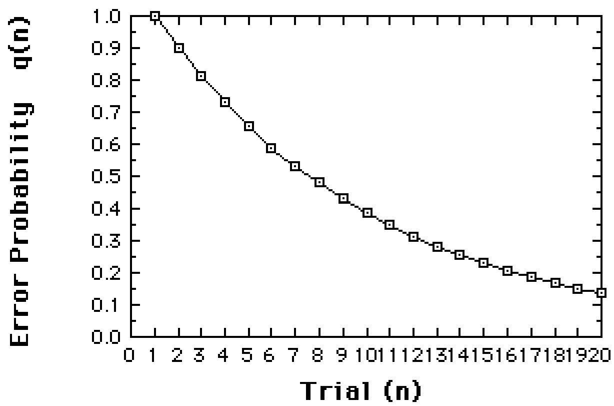
The union of a dynamic scheme networks characterizes complex dynamical systems. Two or more dynamic systems are considered to be coupled when one or more control parameters of one of them constitutes a state function of the other system. Network diagrams are the figures that sum them up. It is possible to break a huge dynamical system into several components, each with their own control parameters, or to combine several simpler systems in a bigger one, as a network with the control parameters of each dependent system in the state of some of the others.
When a system's control parameters are influenced by the state of the system itself, we can talk about *self-control* or *self-organization*.
From the mathematical point of view then, a dynamical system is a set of functions (rules, equations) that specify which are the variables in a dynamical system that change with time.
If we say that "in Wonderland, Alice's height is reduced by half every minute", the variable height is the changing variable. Variables change with time, parameters do not. Discretionary variables are restricted to integer values (numbers), while continuous ones are not.

A system's *present state* is specified by the present value of its variables x, y, z, etc. *Iteration* is the process of calculation to establish the new or future state of a system.
To evaluate the behavior of a system, functions, parametric values and initial conditions or states of the system are required.
Dynamical systems are "deterministic" if there is a single consequence to every state and "random", "casual" or "stochastic" if there is more than one selected consequence of probability distribution (flipping a coin in a "perfect" way has two consequences with the same probability for each initial state). Most of the non-linear science is about deterministic systems.

A classical example is the *alpha model* of the learning theory specified as *q(n),* i.e. the probability of making a mistake during trial n changes from one trial to the next; thus:
$q(n+1) = ß\, q(n)$

In this model, the probability of a new error is reduced by ß, lower than 1 (100% of likelihood) and higher than 0 (no possibility of occurrence). For example, if the probability for an error occurring during trial 1 is 1; and ß equals 9 (90% of probability), the system's dynamics -i.e. what is the probability of errors in each of the following trials?- may be calculated through iteration of the function. The result can later be plotted like this:

q(1) = 1
q(2) = ßq(1) = (0.9) (1) = 0.9
q(3) = (0.9)q(2) = (0.9) (0.9) = 0.81, etc



Probability of error for the Alpha Model assuming that q(1) = 1.ß = 0.9

This "learning curve" is about a *time series* (each successive trial represents a certain moment). Certainly, the idea that there are systems that change along time is not new, nor is it new the notion that these changes are probabilistic. What is actually new is the concept of *deterministic non-linear dynamical systems*, i.e. systems changing along time in a specified way.

A linear function, as we have seen before, is that whose representation is a straight line. Its mathematical formula is: x = mx + b.

In this sense, the Alpha model of the learning theory is a linear model because *q(n+1)* is a linear function of *q(n)*, although the line resulting from the plotting of the system's behavior along time (see above) is not a straight line but a curve.

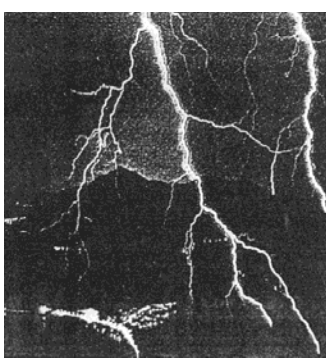
What determines the non-linearity of a dynamical system is the non-linearity of the function specifying its change rather than the non-linearity of its behavior. In this sense, y is a non-linear function of x, if x is multiplied by another variable (not constant) or by itself (i.e., becoming an exponent).

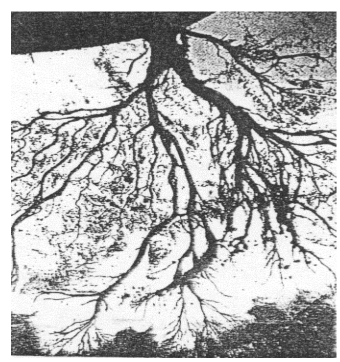
3.3.1.1 Dissipative Dynamical Systems

Most of the basic experiments in electrophysics are due to the 18th century German physicist and philosopher Georg Christoph Lichtemberg. He is responsible for the electrostatic printing, known today as xerography. He pioneered the experimental demonstration the electric nature of lightning bolt. In stormy days, he would go to Heinberg mount in Gotinga and put up a kite tied to thin wire (a rather dangerous experiment) in order to measure directly the currents received.

In connection with lightning bolt, Lichtemberg writes: "Isn't it peculiar that the fast moving lightning bolt hardly ever or never follows a linear trajectory and can easily be conducted?" It can be inferred from this that wave trains do not move away indefinitely, but they follow one another with a high level of proximity. This explains the nature of lightning bolt as an electrical charge jumping from an ionized particle to another. The wave train does not

spread away indefinitely to the distance but “evolves”. At a certain moment it adopts an irreversible decision as to the path to follow.
Similarly, the outlet of the Paraná River into the Rio de la Plata is also a *decision tree*. The different branches of the delta decide the direction they wish to flow in function of the current (energy provider), of the sand particles being dragged and of the sandbanks, wind and tides. It is not possible to predict the trajectory of the different branches. Although a geophysicists may know the nature of mud (sand or mire, etc.), the current gradient, the weather conditions, the average water temperature, etc., they can only state certain empirical values as to the structure and shape of the delta: e.g., whether it is marshy, highly branched out, filtering or if it branches out into a few main currents, or if bushes are to grow rooted in the other bank or whether everything will start all over again next year. These scientific forecasts, however, can never predict individual events and shapes in this delta. Why? Because a river delta is one of Prigogine’s dissipative dynamical structures [22].
The same occurs with a tree. Although there is a basic genetically established program for the tree, a pine tree will always be different from a poplar, which in turn will always be different from an oak tree. But within the scope of the variation of the genetic system, the shape of the tree is not predictable. When and where a new bud will be inserted, how quickly and how strong it will grow maybe at the expense of other branches and whether it will take up more light than the others, what the influence of the tree’s location is, the weather factors, the seasons ... all of these things cannot be calculated. In addition, a tree is a system that develops following a genetic program with branching points that carries high energy substances (living organisms) that dissipates energy and therefore, irreversible decisions are taken. Considering the same concept, it can be said that a tree is a de-accelerated lightning bolt; the time scale is 10^{12} slower.
Systems like lightning, trees or deltas, presenting family tree shapes, contain *ramification* points where there are competing alternative paths with the same rights. It is not possible to predict the selected path. The strictly deterministic initial conditions do not allow for predictions as to the ramification points of dissipative systems. These ramification points are mathematically called bifurcation points (Latin: “furca” = “fork”) or fulguration (Latin:“fulgur” = “ray” or “lightning bolt”)[23].





Lightning bolt, trees and deltas are dissipative dynamical systems

[22] Ilya Prigogine, *Las Leyes del Caos*,(Barcelona, CRÍTICA Grijalbo, 1997), page 27.

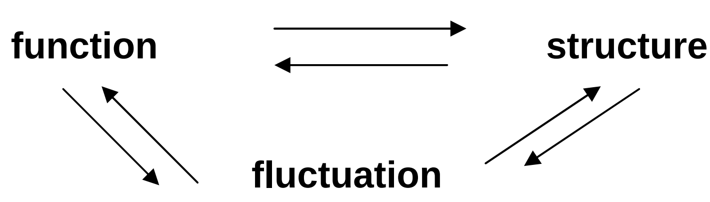
[23] Friedrich Cramer, *Chaos und Ordnung. Die komplexe Structur des Lebendigen. Insel Taschenbuch* (Verlag, 1988). page 148.

All dissipative systems, even if they may vary from the material perspective, are basically identical: they stem from non-reproducible operations, and they develop, live, age and die. But, why do they age and die? In linear systems every operation is reproducible and reversible. The time of classic mechanics and linear systems, is reversible, it has a non-polar structure. Newtonian systems do not age. Instead, dissipative systems with bifurcations do not allow us to go back in time. The bifurcation has taken an irreversible decision. The time axis in a non-linear dynamical system is irreversible. In this sense, time has adopted a totally new meaning.
Bifurcations have important consequences for the possibility of predicting events. According to Prigogine, the concepts from classical physics were based on the definite idea that the future is determined by the present and therefore through the study of the present it was possible to reveal the future. Logically this was obviously no more than a theoretical possibility. However, this infinite possibility of prediction was an essential element in the scientific image of the physical world. It could be called the fundamental myth of the classical science.

Prigogine developed the theory of dissipative structures, of far from equilibrium systems and in his acceptance speech when awarded the Nobel Prize he expressed: “In far from equilibrium conditions, an unexpected relation between the chemical kinetic and the space-time structure of reactive systems appears. Interactions -that determine the values of relevant kinetic constants and of carrier quotients- come from short interactions (valence forces, hydrogen links, van der Waals forces) but the solution of kinetic equations depend on global relations”.
When studying lightning, Lichtemberg said that “*wave trains do not go away indefinitely but they follow one after the other at great proximity*”; he clearly expressed that “short extent interactions” are the fluctuations of air molecules with electrical charges, and that “global relation” is the electrical field between the storm clouds[24].

According to Prigogine, this dependence between the short extent and global relations - that in equilibrium thermodynamics is trivial- in far from equilibrium chemical systems is decisive. For example, for dissipative structures to appear in general the size of the system is required to exceed a certain value. This value is a complex function of the parameters, which describe the diffusion and reaction processes. Therefore, he states that “*in chemical instabilities there is a distant order through which the system acts as a whole*”[25].

Three aspects are always interconnected in dissipative structures: the *function* as expressed in chemical equations, the *time-space structure* derived from instabilities, and the *fluctuations* that bring about instability.



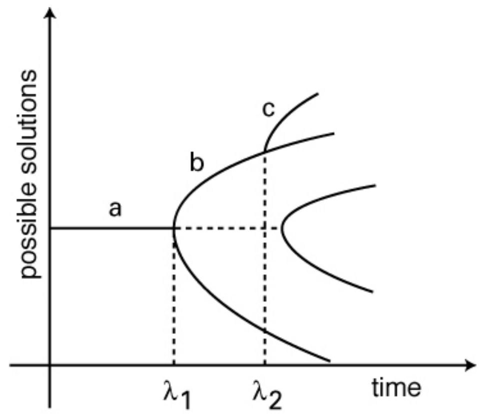
[24] J. Briggs and F.D. Peat, *op.cit.*, page 144.

[25] J. Briggs and F.D. Peat, *op.cit.*, page 137.

The reciprocal influence of these three aspects leads to highly unexpected phenomena, as well as to "*order through fluctuations*"[26].

3.3.2.2 Bifurcations

In general, we obtain ramifications or bifurcations that happen one after the other when we increase the value of a certain characteristic parameter.
The following figure shows a single solution for the λ1 (lambda) value and two for the λ2 value.

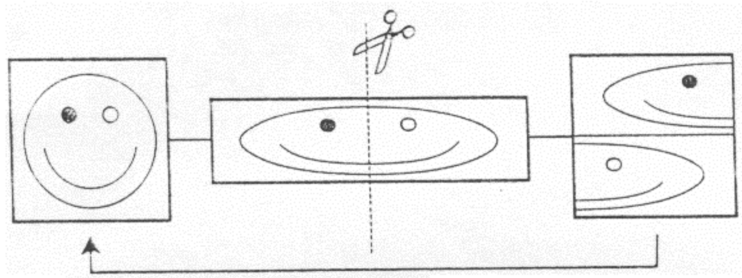


It is interesting to notice that the ramification introduces an element of "history" into physics. Let us imagine that the result of an observation shows that the system above is in state c and that it has reached the state by incrementing λ. The interpretation of this state c implies the knowledge of the history prior to the system which, through bifurcation points has gone towards a and b. In this way a "historic" element is introduced into physics and chemistry, which so far appeared to be reserved to sciences dedicated to biological, social and cultural phenomena.

Any description of a system with ramifications will contain necessary (deterministic) and random (non-deterministic) elements. When a system is in states between two bifurcations, it obeys deterministic laws as chemical kinetic laws, while in the proximity of bifurcations, fluctuations play an essential role since they determine the "branch" where the system will keep on moving.
The mathematical description of bifurcation systems called for an orbit with cracking points, a discontinuous transformation; as such, Prigogine proposes the so called Bäcker's transformation: through a simple geometric operation a deterministic system becomes non deterministic by stretching a drawing (a face in this case) as a piece of dough, cutting it in the middle and joining it back again, shaping it into a new square[27].

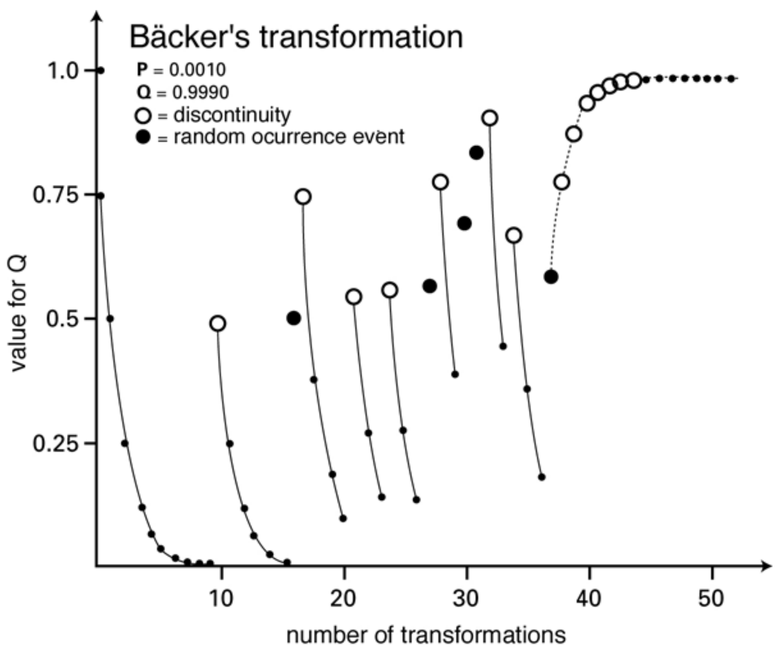
[26] Friedrich Cramer, *op. cit*. page 149.
See also: Ilya Prigogine, *L'Ordre issu du Chaos*. (París, Monograph of the Institut du Management d'EDF et de GDF. 1997).

[27] Friedrich Cramer, *op. cit*. page 151.



Bäcker's transformation of a square pattern. The square is stretched to double its length and half its height, it is cut in the middle and both pieces are re-united to form a square shape again. The process is repeated several times in a sequence.

In the example, the nth transformation displays an "ordinary" discontinuity; in transformations 16, 27, 30, 31 and 37, a bifurcation.



Bäcker's transformation

This is a strictly deterministic and simple operation. If we follow the trajectory of a point, e.g. the eye's pupil in a system of coordinates, there are unpredictable irregularities. The point starts to jump until it disappears completely from the system.

Uncertainty increases qualitatively at each bifurcation. The bifurcation from a limit attractor produces first order non-linearity. It is small and often dismissed as observer error, technical error, incomplete measurement or just plain bad theory. A second order form of change occurs when a torus becomes a butterfly attractor (in fact, a butterfly attractor can be viewed as two connected tori). This change is qualitatively different from the small variations found in a torus. The great difference in behavior observed in the two wings of a butterfly attractor is often interpreted as proof of the existence of unknown intervening variables. Third order change occurs when another small increase in a key parameter drives a system (or set of systems) into deep chaos.

That which, at one scale of observation, is process can be understood as structure at a more macro-scale of observation. Structure in chaotic regimes emerges as iterations proceed and transient states disappear. On the other hand, structure in chaotic regimes is stabilized (locked-in) as other systems begin to occupy the niches provided by the new system (or set of systems). In turn, the energy and raw materials from companion systems limit the behavior of the first. Think of a new species of a tree in a biome, which harbors other plants, and animals, which in turn provide pollen, seed dispersal, protection from insects, fertilizer, and aeration of soil. The whole eco-system becomes stabilized in second order change patterns until a key parameter (weather, predator, food supply, and moisture) exceeds a critical Feigenbaum point. These structures are themselves fractal and self-similar. Therefore, the system in process is itself a product of other, more basic systems in process. Chaotic regimes thus produce very stable structures at macro-analytic scales (when throwing dice, any given throw does not change the uncertainty of the next throw, but all throws taken together define a very stable structure).

Our mental landscape stretches out and compresses everyday; it folds over itself and the effect is similar to Bäcker's Transformation. Ideas, associations and convictions that were close to each other get separated and vice versa.

In the human and social field, as complexity grows and more areas of human existence move towards critical bifurcation points, periods of relative stability between discontinuous transformations seem to shorten. The average number of years couples staying married shortens as divorce prevails. For the last thirty years, schools have gone through many changes and transformations. The main transformations of basic institutions take a faster pace. It is practically impossible to find a single institution that has not gone through at least one transformation in its lifetime. Companies engage in mergers or alliances in increasingly competitive and dynamic markets and the periods between transformations are getting shorter and shorter.

For individuals, shorter periods between transformations mean that they will have to deal in their lifetime with transformations that once upon a time would have been dealt with by a future generation. The children used to carry out the changes that their parents found too threatening. But nowadays, people cannot delay transformation until the next generation.

In our everyday world, we are used to the idea that the "neighborhood" where we live in works without problems, that events take place linearly and without disruption. That's the way we have been brought up and our technical world teaches us daily to trust in the functioning of continuos operations. Having been able to discover laws and rules where nature is inserted is a great achievement of natural sciences that allows for all types of forecasts. However, in decisive matters, where something new appears, everything is suddenly uncertain. Despite the consideration of all possibilities and the inclusion of all physical relations in the system, it adopts an unpredictable "de-cision", a bifurcation.

As more political systems, ideologies, cultures, nations, societies, governments, cities, institutions, organizations, families and individuals become increasingly complex and collapse or go through chaotic and turbulent transitions, the human world becomes more uncertain and is unable to function adequately[28]. This is a society in the midst of the

[28] "Behavioral and social systems are not only complex systems, but they are complex systems that are becoming more complex as they become more differentiated, more intricately connected, and organized internally and externally. They are changing more rapidly and consuming more energy to maintain their differentiation, organization, and coherence." Merry, Uri: *Coping with Uncertainty: Insights from the New Sciences of Chaos, Self-Organization, and Complexity*. (Connecticut, Praeger, 1995. page 73)

chaotic phase of transformational change. "*What currently happens is not a crisis of capitalism but of the same industrial society, regardless of its political regime. We are simultaneously experimenting a revolution of the young, a sexual revolution, a racial revolution, a colonial revolution, an economic revolution and the fastest technological revolution in history. We live through the general crisis of industrialism*" [29].

This is an increasingly unpredictable human world. People go to sleep without knowing what will occur on the following day and how it will affect their lives. The former regularities become increasingly disorganized. Randomness, uncertainty and unpredictability, stress and crisis play an increasingly crucial role in human life. This is a world where the proportion between cause and effect is becoming less and less palpable. In times of discontinuity, generalization of events is increasingly harder. Randomness is entering in human life with more strength and a heavier impact.

Predicting and planning the future is also more difficult since in times of discontinuous changes and of frequent and unpredictable bifurcations in the social system, the trajectories of the future become impossible to calculate. And the world's increasing uncertainty threatens the individual and social needs for order and regularity. The foundations of life in a world supported by firmness, regularity, stability, certainty, order, predictability, generalization and control collapse. The progressive disappearance of these characteristics and the prevailing increase of crisis and deep chaos result in stress, anxiety and fear. "*There is no guarantee for humanity to stand on firm land*"[30].

Societies, organizations and individuals react against this threat with big efforts to retain control. They try to re-create certainty and regularity by dominating and controlling the human and circumstantial environment. They do all this using the same means that they used in the past to gain control, but with more structure and technology.

However, they just close the vicious circle of a self-supporting system.

Advanced technology leads to greater complexity, multiplying the level of crisis and transformation, and generating more adjustment difficulties since the world that humanity struggles to dominate through science and technology becomes more uncertain. According to Orenstein and Ehrlich[31], each technology triumph contains new types of threats. Rifkin says that each attempt to force order with new technologies will only accelerate chaos. The more we apply technological solutions to the world, the more things seem to corrupt and disintegrate. "*Bifurcations occur in increasingly frequent successions which leads to a more and more disorganized world. Every time we apply a new technological solution to a problem is like trying to put out a fire with gasoline. The increasingly complex process, with greater problems, entropy and more disorder develops exponentially; that is the reason why the modern world crisis causes so much fear*"[32].

From the mathematical point of view, a bifurcation is a period duplication change from an n-point attractor to a 2n-point attractor when the control parameter is modified.

The visual synthesis of the succession of period duplication thus generated in a computerized graph is called *bifurcation diagram or map*. The following picture shows a bifurcation diagram in a logistic map; r increases along x due to hundreds of iterations.

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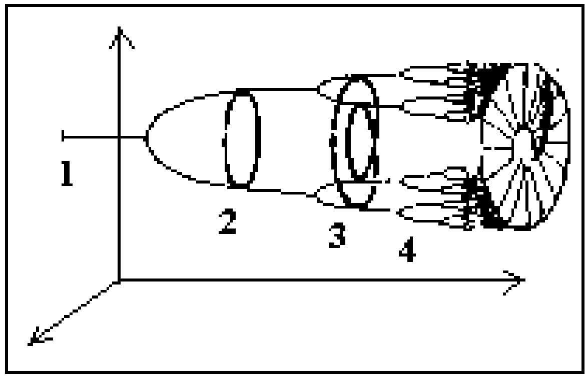
[29] Alvin Toffler, *The Third Wave*, (London, Pan Books, 1981)

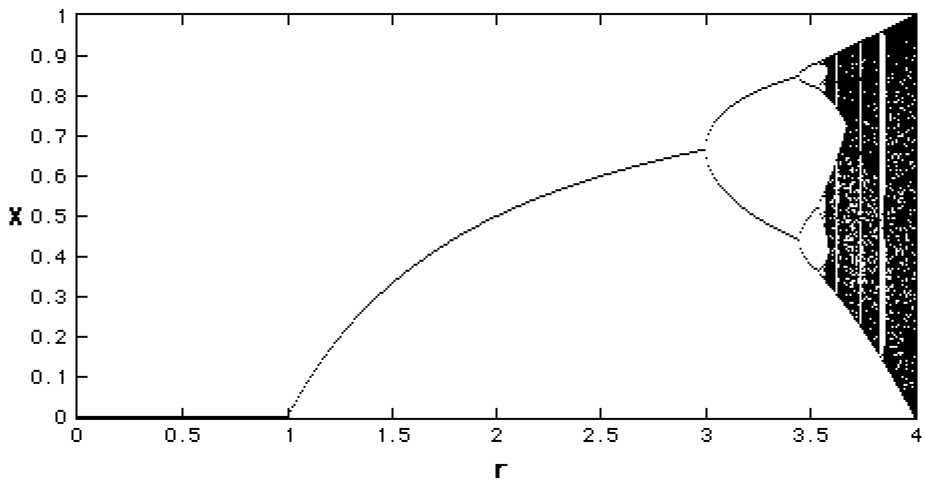
[30] T.R. Young, *Chaos and Causality in Complex Social Dynamics*. (Michigan, The Red Feather Institute, 1994).

[31] Robert Ornstein and Paul Ehrlich, *New World, New Mind* (New York, Simon and Schuster, 1990)

[32] Jeremy Rifkin, in *tropy: a New World View,* (New York, Bantam Books, 1981). page 115.

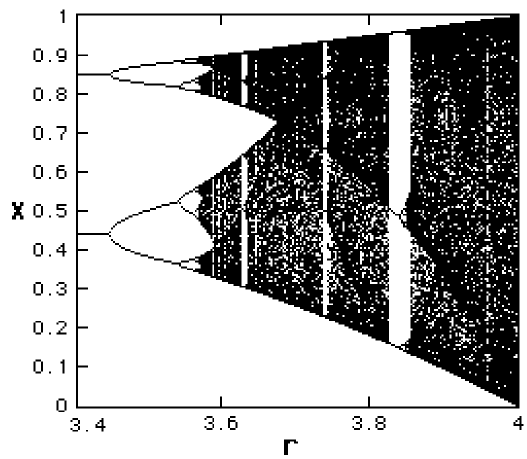


Bifurcation with duplication of periods in the phase space.



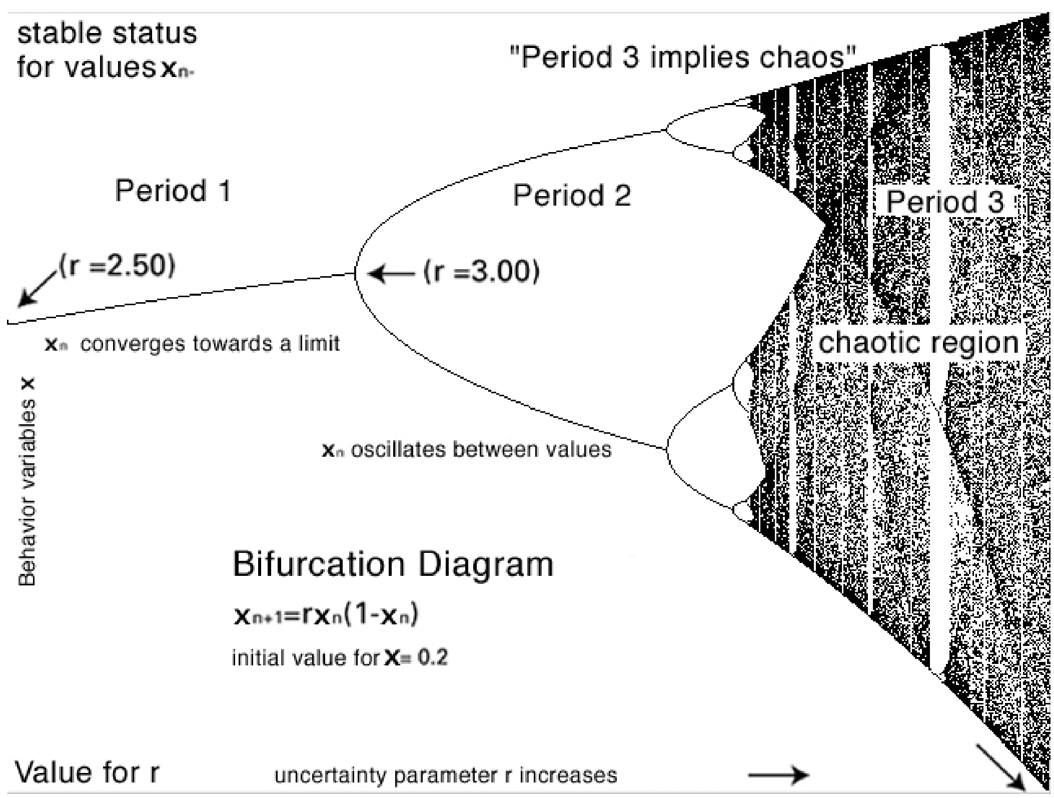
Bifurcation diagram; r is between 0 and 4.

It can be demonstrated that for r lower than 1, all points have been plotted to 0. Zero is the point attractor for r lower than 1. For r between 1 and 3 point attractors are maintained; however, the value "attracted" for x increments as r increments as well. Finally, when r = 3, bifurcations occur in r = 3, r = 3.45, r = 3.54, r = 3.564, r =3.569 approx., etc., up until immediately after value 3.57 where all the system becomes chaotic.
Anyway, the system is not chaotic for all values of r higher than 3.57.
An enlargement of the diagram above shows:



Bifurcation diagram for r between 3.4 and 4

Please observe that there is only a small number of values corresponding to certain values of r higher than 3.57. These regions produce blank spaces in the diagram. Observing r = 3.83 carefully, a three point attractor will appear. In fact, between 3.57 and 4, there is a rich intercalation between chaos and order. A small change in r may turn a stable system into a chaotic one and vice versa.



Non random chaotic systems can appear to be so. They share simple characteristics that define them:

- They are deterministic, i.e. they have something that determines their behavior.

- They are very sensitive to initial conditions. A small change in the starting point can lead to completely different outcomes. This makes the systems quite unpredictable.

- They appear to be disordered, random. But they are not. Beneath the random behavior there is a sense of order and pattern. True random systems are not chaotic. Orderly systems, forecasted by classic physicists, are exceptions. In this world of order, chaos is what actually rules.

- Order in chaos is a holistic order and results from mutual effects. It is the result of interdependent variables that mutually affect each other and whose result is a hidden holistic pattern. It does not come from any variable, it does not go straight, and it does not imply a fixed sequence. It is the order of the whole that gives an explanation for the "mysterious" hidden global order (an "invisible hand"). Adam Smith spoke about an invisible hand behind economic transactions. Hegel described the evolutionary world through dialectic and order under superficial matters. Systems of mutual effects that create the order out of the whole provide a mechanical foundation for this type of observation. The activity of the elements of the system's mutual effects creates a global order; this mutually created global order exerts pressure on every individual element towards a global pattern. Go-carts for toddlers to learn to walk is a simple example of this mutual global effect phenomenon. Walking with the cart makes you move, but this movement creates the pressure to keep on walking and to walk more quickly. In a complex system of mutual effects, the phenomenon tends to be subtle, omnipresent, and quite powerful.

- While chaos is the study of how simple systems can generate a complex behavior, complexity is the study of how complex systems can generate simple behavior.

3.3.3 Morin's Three Principles

In his work *Introduction to Complex Thinking*, Edgar Morin[33] says that complexity contains three characteristic principles. The first one is called *dialog principle*, and is described with this example: "Let's imagine a living organization. It was born from the encounter between two types of physical-chemical entities: DNA, a stable type that can be reproduced and whose stability can be self transported through a memory that is then inherited and on the other hand, multiple shaped and extremely unstable amino acids, that form proteins; they degrade but constantly reconstruct out of messages from DNA. In other words, there are two criteria: the unstable one, which lives in contact with the environment and allows the phenomena existence and another that assures reproduction." These two principles are not simply juxtaposed but they are mutually dependent. The sexual process produces individuals who in turn produce the sexual process. Both processes are complementary but at the same time they can be antagonistic, e.g. some mammals eat their breed, sacrificing them to their own survival.
Order and disorder are enemies. One suppresses the other but in certain cases they mutually collaborate and produce organization and complexity.

[33] Edgar Morin, *Introduction to Complex Thinking* (Spanish edition: Barcelona, Editorial Gedisa, 1996)

The dialog principle allows the duality in the heart of duality by linking two complementary and antagonistic terms.

The second principle is *organizational recursiveness*. A recourse process is that in which products and effects are simultaneously cause and producers of what produces them. We are producers of a reproduction process previous to us, but once we are produced, we become producers of the process that is to continue. Society is produced by interactions among individuals, but society, once constituted (produced) counteracts on individuals and produces them. In other words, individuals produce the society that produces individuals. We are products and producers at the same time.

Finally, Morin's third is the *hologram principle*. In a photographic hologram, the smallest point of the image contains almost all the data of the object. Not only is the part in the whole, but the whole is in the part. The hologramatic principle is both in the biological and sociological worlds. Each cell contains all the genetic information of the organism it belongs to. Pascal said "I cannot perceive the whole without its parts and I cannot perceive the parts without the whole".
Morin connects his three principles with the following reflection: "In recursive logic, we know very well what we acquire as knowledge of the parts re-enters the whole. What we grasp about emergent qualities of the whole -whatever does not exist without organization (without system)- re-enters the parts. We can therefore enrich the knowledge of the parts through the whole and vice versa in the same knowledge producing movement. The hologramatic idea is then connected to the recursive idea that, in turn, is connected to the dialog idea, which was the starting point[34].

3.3.4 The Two Principles of Causality

Beyond Morin's three principles, the whole as a complex system is subject to two principles of causality whose axiomatic and unquestionable co-existence is one of the pillars of almost all sciences.

In some cultures of the past human sacrifice was usual in order to obtain the sun's complacency; nowadays, it is unlikely to consider someone a fortune teller or prophet for proclaiming that the sun will rise tomorrow.

The decisive and triggering element of this development was the understanding of the mechanics of heavenly bodies, i.e. the understanding that nature obeys laws which allowed for accurate calculation of sunset and sunrise. There was an "oracle" formed by abstract mathematical formula that responded to questions about the future in an accurate and reliable manner never seen before. Up to date this oracle is being consulted, it is cared for and it is enlarged when necessary. Its basic principle is causality.

Causality means concatenation of cause and effect. Everything that occurs has a cause and a cause unequivocally determines an effect. If causality is attributed a temporal dimension, one event can be referred to a past cause. By the same token, this leads to the conclusion that every cause has an accurately specific effect in the future.

[34] Edgar Morin, *op. cit.*

Once the real state of a system is known, as well as the influences that it is subjected to, it is possible to predict its future development. A system that starts repeatedly in identical conditions will have an identical behavior in all cases. In other words, we can say that identical causes have identical effects. However, conclusions cannot be drawn as to how small changes in the causes may influence the effect. In this sense, the weak causality principle establishes a relatively weak demand, thus the following principle:
"<u>identical causes, identical effect</u>", which is also called *weak causality*. The weak causality principle as such does not provide enough scientific grounds to discover laws in the conventional classical sense.

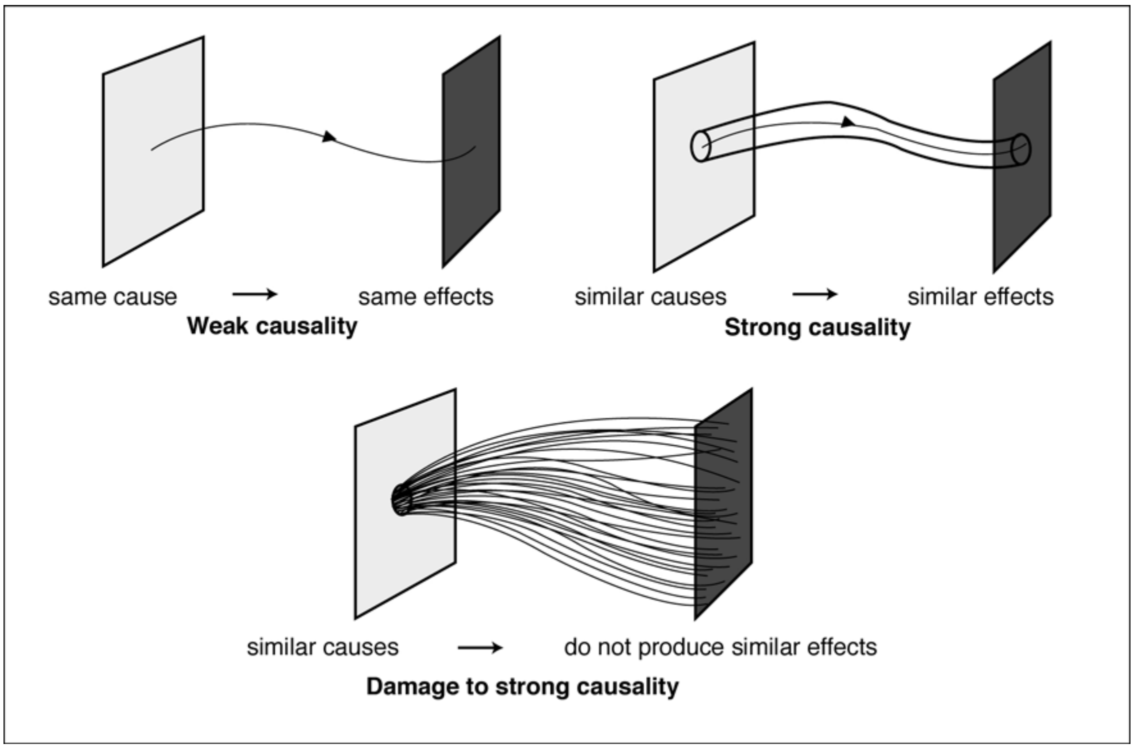
The supreme demand for a valid experiment is its reproducibility. Every repetition, under the same conditions, must produce the same result. Identical repetitions of an experiment, however, are basically impossible. Accuracy always has a limit, so minimal margins are always inevitable. Measuring magnitude more accurately than the inaccuracies of an experiment will allow seems to be a paradox. However, the errors resulting from measurement should be located in the same range as the inaccuracies of experimental conditions, i.e. they should be "similar". Reproducibility lies then on a much stronger causality principle:
<u>"*Similar* causes have *similar* effects"</u>. This *strong causality* comprises the weak principle but goes well beyond. The weak causality principle attributes exactly an effect to a cause. Nevertheless, it leaves open questions as to the relation between the cause-effect combinations, starting from different causes. Even further, the strong causality principle is concerned about the development of similar causes. It supports that the causes surrounding a specific causal environment appear again in the surrounding of the point of effect assigned to it. Violating this strong causality principle would even seem grotesque. Loistl and Betz[35] provide the following example: "*If an archer made even a minimum change to the position and tension of the arch, his arrow should be sent in all directions. However, this is not so; the strong causality principle is not violated; therefore, a slight change in the optimal position makes the archer improve his performance: he first reaches the concentric circle until he aims the target. The higher the precision to the optimal conditions the more he will aim the target.*"

This apparently trivial causality principle was accepted as an axiom for classic deterministic mechanics, showing no objection on the part of science. The authors wondered: could a deviated arrow going in any direction harm the strong causality principle and contain an univocal law of motion?
Obviously no, according to the ideas of the time. Therefore, non-reproducible measurements were left aside hoping for better methods and deeper knowledge of relations not yet explained. Possible damages to the strong causality principle were ruled out. In 1876, J.C Maxwell referred to this principle: "A frequently quoted phrase says: identical causes always produce identical effects. For a thorough understanding of this phrase we should define the meaning of identical causes and identical effects; it is obvious that as an event never occurs more than once, causes and effects cannot be identical in all relations ... Another principle that should not be confused with the one quoted above says: Similar cause generate similar effects. This is correct as long as small changes in the initial condition of the system only generate small changes in its final condition. This

[35] Otto Loistl and Iro Betz, *Chaostheorie. Zur Theorie nichtlinearer dynamischen Systeme*. (München, Oldenbourg Verlag. 1996).

condition holds true in a great number of different phenomena; in others it does not, as when the change of railway provokes a train crash instead of following the established route."[36]

While developing his studies to prove the extent of interference of planets on the earth orbit around the sun, Poincaré also observed that strong causality could be damaged. In 1908 he wrote: "*A tiny and unperceived cause determines a considerable effect that cannot be left unnoticed and this effect is attributed to randomness. If natural laws and the state of the Universe were known with precision in the initial moment, we could determine the condition of this universe in a later moment. But even if natural laws were deprived of secrets, we could only determine initial conditions by approximation. If this approximation allowed us to predict the following situation within the same approximation -this is all we demand- we could say that the phenomenon had been forecasted and that it obeyed the laws. But this is not always so; tiny modifications in initial conditions may finally generate big differences in phenomena. In that case, a small invisible error may result in a big error. Predictions become impossible and we are witnessing a random event*."[37]



Causality principles and damages to it

Nevertheless, the idea of damage to the strong causality principle was abandoned. In 1963, while observing the change of theoretical meteorology, Lorenz provoked another

[36] J. C Maxwell, *Science and Free Will*

[37] Ilyia Prigogine e Isabelle Stengers, *La Nueva Alianza – Metamorfosis de la Ciencia*, (Madrid, Alianza Editorial, 1994), page 107.

independent impulse. He came across his simplified model of atmosphere with a system showing a dynamical behavior which:

- seemed to obey natural laws
- met the weak causality principle but
- violated the strong causality principle.

While working on the mathematical model of climate, Lorenz found one way of dynamical behavior of the system that violated the strong causality principle while meeting weak causality. He called this behavior of the system "sensitivity to initial conditions".
The structures and institutions found in modern society are other open systems with irreversible processes, interwoven causal chains and multiple feedback loops; they originate the annulment of strong causality and the possibility of chaotic reactions.
After one decade scientists decided to consider the violation of the strong causality principle.

3.3.5 Non-linear System Interdependence

The repeated stretching and folding of the dough as in Bäcker's transformation simulates the amplification of small, initial differences in phenomena that are related to each other. However, non-linearity and sensitive dependence alone are not enough to create chaotic conditions in systems. When it isolates them, modern physics is able to deal with non-linear independent systems. Calculus can solve many non-linear problems of isolated systems.
Chaos develops in non-linear systems that are interdependent with each other. Non linearity is not the same thing as interdependence. Non linearity deals with proportionality. It expresses a disproportion between cause and effect: small causes may lead to large effects and large causes may have small effects. Interdependence is another matter: it deals with relations between things and the ways in which they affect one another. Members of a family or an organization are interdependent. Their behaviors affect one another. Our body and components of our personality maintain a relationship in which they constantly affect each other. Communication and social interaction are interdependent.
Modern science attempted to deal with systems in a manner that isolated them from all that was around them. Newton's equations worked with isolated objects. The famous French scientist Henri Poincare added to a two-body system the influence of a third body, another planet or moon. His calculation showed that in some orbits a planet might begin to wobble and the system could begin to exhibit some chaotic behavior.[38]
Sally J. Goerner of the *Triangle Center for the Study of Complex Systems* (USA) writes that the most crucial insight in the non-linear revolution comes from non-linear *interdependent systems*. [39]
In this world there are in effect no absolutely independent systems. There are different degrees of mutual effect and interdependence between systems, but never absolute

[38] Ilya Prigogine, *Las Leyes del Caos*,(Barcelona, CRÍTICA Grijalbo, 1997), page 73.

[39] Sally Goerner, "Chaos, Evolution, and Deep Ecology" in *Chaos Theory in Psychology and the Life Sciences*, (Robin Robertson and Alan Combs(editors), New Jersey, Lawrence Erlbaum Associates, Inc., 1995). page 17

isolation. Goerner points out that independent systems are idealizations. In this world there are no truly linear systems as there are no truly independent systems.
When a human system changes, it affects other systems around it. When a member of a family changes he or she affects the other members of the family. When family members react to the change, their reactions may feedback on that person and affect how he or she continues affecting the people he or she interacts with. When a father shouts at his son, he reacts and this affects how you continue to behave. When changes in Palestine affect the UN forces, they react and their reaction affects the Palestinians whose reaction again affects the behavior of the UN forces, and so on.
In human and social systems of all kinds, when feedback cycles like these continue to occur, interdependence develops. In this way repetitive cycles of changes between interdependent human systems that are affecting one another may contribute to the development of chaos.
The interdependence of people within organizations is necessary but it also has the potential to enable the organization to go through chaotic episodes.
In a certain sense, chaos reveals the unity of the universe and the hidden tie between one thing and another. When people cut up this invisible unity and isolate things into compartment boxes, chaos pokes its head up to remind them that they are living in a holistic, indivisible world. Interdependence alone does not create chaos but its combination with non-linear sensitivity to initial conditions increases the probability of chaotic conditions.
The increasing connections, interactions and interdependence between non-linear systems (such as human societies) are an inevitable aspect of evolution, while they prepare the fertile soil for proliferation of chaotic states.

3.4 Attractors

An attractor is defined as a point towards which a system tends to move, either deliberately or forced, along the regulating parameters. From the point of view of mathematics, it is defined as a set of points of variables of a dissipative system in space to which orbits or trajectories tend to move during dynamical evolution. Attractors are creatures living in an abstract place called *phase space*. It is quite simple to visit this space, but the voyage requires a map. The act of reading the phase space maps and of learning to identify attractors leads from the familiar world of order world to the edge of chaos. As will be seen later, non-linearity and feedback manifests at this turbulent edge in a manner called *strange attractor*.

Maps are simplified and schematized images that allow us to concentrate in aspects of reality that would otherwise get lost amidst details. A typical example is a road map. There are hundreds of different types of maps to guide us in geography (e.g. orographic maps), economy (stating how the country size is related to the individual income), health (e.g. showing the gradual advance of an epidemic illness) or any discipline we can think of.
A map allows us to appreciate some features of reality that we would otherwise overlook, and helps us explore this reality in such a way that would seem impossible without a map. Like a climber who uses a map to verify altitude, longitude and latitude in order to explore his reality and know where he is, scientists who wish to explore the reality of a dynamical system use a map to approach dynamics, e.g. the way in which the system moves and transforms.

Let’s assume that the object of study is the changes of a car in motion driving from Buenos Aires to San Pablo (stops, de-acceleration and acceleration). It is obviously not enough to specify where the car is at every time; speed data is also required. The analyst could then generate a graph of these two aspects of the changing motion of the vehicle. As was seen above, scientists call to the imaginary space in the map where the car’s recorded motion appears *system phase space*.
Phase space is formed by as many dimensions (or variables) as the researcher needs to describe the system’s motion. In a mechanical system, the system phase space is usually recorded in terms of position and speed. In an ecological system, the phase space may be the number of members of various species.

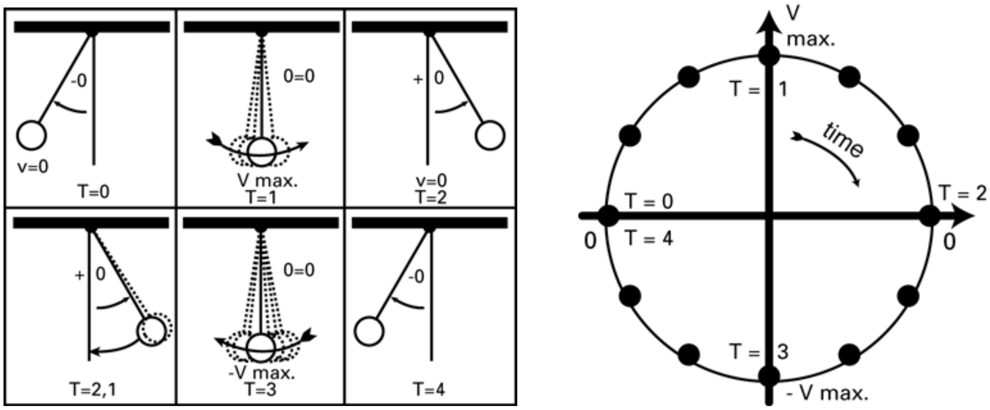
The map for a rocket launched into space to place a satellite in orbit may be described as follows: each point in the map is a snapshot of the rocket’s altitude and speed (or its momentum = mass x speed) at a specific point in time. If we draw a two coordinate graph, where the vertical axis represents altitude (position) and the horizontal axis represents speed (reached by the spacecraft), we would obtain a curve whose starting point would be zero speed and zero altitude. As the spacecraft increases its speed and altitude, after the launching, the curve on our map would have a slope of around 45 degrees until the spacecraft ends the first stage and de-accelerates due to gravity. In the graph, although the curve would keep on ascending, it would do so with a certain backward “loop” since speed is reduced. Speed would gradually reach a normal level and the curve would follow its original trajectory until it ascends vertically once the gravitational force is overcome.
As it can be observed, a trip in the phase space, with an upwards “S”-shape curve differs from a trip in the real space, where the actual spacecraft’s trajectory looks like a spiral starting at the launching point on earth.
Obviously the map described above is very simplified, as a city’s subway map is simplified and differs from the original route of trains along tunnels.
Again: maps simplify reality to emphasize certain aspects. A researcher would have surely considered that a rocket actually moves in the three-dimensional space and would have tried to capture this aspect of motion in a more complex phase space chart.

As the rocket can move in one, two or three dimensions and can reach a different speed in each of them, specially when maneuvering in outer space, the image design of a rocket phase space may contain three dimensions for each speed direction, i.e. a six- dimension phase space (3+3).
The *state* of the rocket (i.e. its speed and position) is given at every moment by a point in this six-dimension phase space. On the other hand, the *history* of the rocket (as it moves) will be given by a line in the phase space called trajectory. Of course, it is impossible to draw these multi-dimensional spaces in our ordinary space. What scientists do to observe the system’s behavior is to draw a two or three-dimensional transversal section of multi-dimensional the space.
It is usual to study the behavior of mechanical systems with multiple components, each of them free to move in one of the three directions at different speeds. As one particle requires a six-dimension phase space (three space dimensions and three speed dimensions) an *n* particle system needs an n-dimensional phase space.
As for the rocket, in theory its description may require a large dimensional space; in practice, all the components of the rocket move at the same speed and maintain the same relative distance between each other. Therefore, to describe the rocket’s movement it is necessary just to consider the three space dimensions and the three directions of the momentum.

This is the standard for stable and orderly systems. Although their phase space may ideally contain a vast number of dimensions for them to move, in fact they can do so in a tiny sub space of this larger space.
The study of a system movement from order to chaos is somehow the study of how this simple and limited notion breaks down to the extent that nature starts to explore all the implications of the larger available phase space.
In their book *Turbulent Mirror: an Illustrated Guide to Chaos Theory and the Sciences of Wholeness*, John Briggs and David Peat say that "systems in nature are like animals that have always lived in cages. If we open the cage, they first tend to move in a limited way without venturing too far, they wander about with repetitive movements. When the animal dares to break this pattern and goes away from the cage, it discovers a whole new universe to explore and escapes in a totally unpredictable way."[40]

One of the simplest and most regular systems is the one that acts periodically, i.e. the one that goes back to its initial condition once and again. A spring, the string of a violin, the sound of an electronic organ, day and night, a car's engine piston, the electrical voltage of alternate current, the church-goers who attend the 11 o'clock mass ... they all oscillate, they are all periodical.
These systems move back and forth, up and down, and sideways so that after every complete oscillation they go back to their initial position. The logical conclusion is that the path of a periodic system goes back to the same point in the phase space, regardless of the complexity of the return path.
A classical and illustrative example is the clock's pendulum. The pendulum swings upwards and to the left, losing speed in the meantime until a certain infinitesimal moment when it stops at its highest point and goes back at an increasingly fast speed. It reaches its maximum speed in the lowest part of the oscillation movement and loses speed again when climbing to the right. The pendulum is one of the simplest systems among those which show this periodic and repetitive behavior. In friction free conditions and without air resistance, the pendulum would oscillate endlessly.
As the pendulum is limited to oscillate sideways in only one direction, according to researchers it has only *one level of freedom*. The rocket has three levels of freedom since it can swing in all directions (each level corresponds to each dimension of the three dimensional space).
The trajectory of the pendulum in a phase space is mapped in a cross-shaped two coordinate diagram; the vertical axis stands for position and the horizontal one for momentum. The coordinate intersection marks value zero for both variables.
The vertical's maximum and minimum points show the maximum left and right oscillation positions. These points will coincide with those of lowest momentum (mass times speed), since it is there where the pendulum stops to start its way back..

[40] J. Briggs and F.D. Peat, *op.cit.*, page 33.



The trajectory of the pendulum

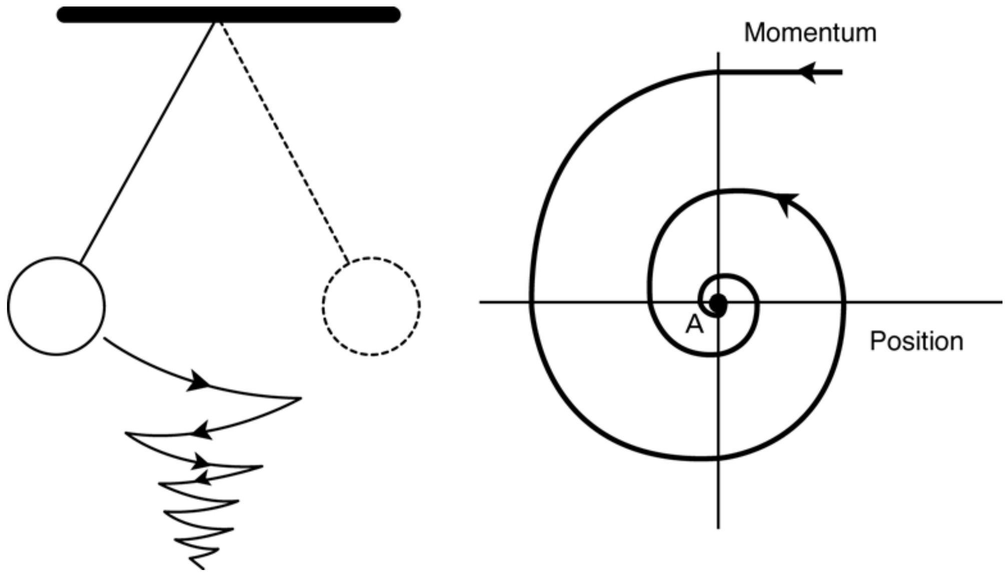
When the pendulum is in vertical position, either coming from the right or left, its movement is zero but it shows maximum momentum. In both cases, its value on the map corresponds to the two ends of the horizontal axis. The trajectory between these four points or phase states is a circumference connecting all intermediate points; it represents the complete movement of the pendulum in a cycle. It is closed (circular) due to the fact that the scheme is repeated cycle after cycle, once and again. If the pendulum gathered additional momentum, its maximum motion point would be further away and the orbit described would correspond to a circle with a longer diameter.

3.4.1 Point Attractor

However, under normal circumstances, pendulums diminish their speed and eventually come to a halt due to friction and air resistance. This deterioration of a periodic orbit can be represented by a phase space map. Instead of a circumference, the trajectory will show a spiral shape whose final point is the intersection of the two coordinates, where all values are zero (the pendulum has stopped, i.e. it is still).
As this point seems to attract trajectories, mathematicians call it *attractor* or *fixed attractor point* or *point attractor*.[41]

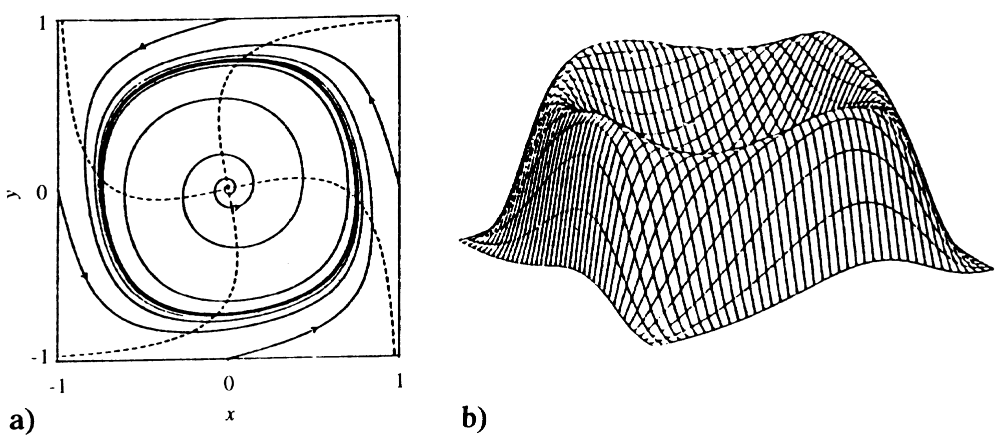
As we have seen before, the attractor is a region of the phase space that exerts a “magnetic” attraction upon a system and seems to drag the system to itself.
Another way of picturing an attractor is visualizing a hilly landscape around a valley. Round and smooth rocks roll downhill to the bottom of the valley. It does not matter what the starting point was or their speed. They will all finally end up at the bottom of the valley.

[41] Moisés J. Sametband, *Between Order and Chaos: Complexity,* (Spanish edition: Buenos Aires, Fondo de Cultura Económica de Argentina, 1994), pages 55- 57.



In point attractors, all plotted data converge to one single point

A landscape may contain two attractors and a bridge in between. It is even possible to have a high mountain acting as a "repeller" of the point. In that case, the phase space trajectories avoid the repeller and move towards the attractors.



Attractor in logistic map a) and phase space b)

3.4.2 Limit Cycle Attractor

The pendulum in some modern clocks has decoration purposes because the clock is electrically propelled (by quartz). The electrical components of the clock mechanism provide the pendulum with periodic momentum. Friction and air resistance gradually stop the pendulum, but the generating force of the electrical system makes it recover its regular speed by acceleration. Thus the pendulum oscillates regularly despite friction and air resistance. Even if it received an additional impulse, or if someone willingly stopped it, it would quickly recover its pre-set rhythm. This is obviously a new type of attractor. The

pendulum is not attracted to a fixed point, as in the previous case but it is driven to a cyclical path in the phase space. This path is called *limit cycle*, or *limit cycle attractor*.[42]
It is worth mentioning that although the pendulum in the vacuum completes its cycle unchanged, its movement does not imply a limit cycle because the slightest disturbance alters the pendulum's orbit, either expanding or reducing it. But a mechanically driven limit cycle pendulum resists small perturbations. According to Briggs and Peats, "*if we try to get the system out of the cage, it runs back home*"[43].
The limit cycle's aptitude to resist change through feedback is one of the paradoxes discovered by the sciences of change. Researchers have discovered that nature has a way of changing things continuously to find change-resistant systems called histeresis. Bacteria or insects that mutate to resist antibiotics or pesticides are just two out of a long list of examples.

A good example of limit cycle attractor is found in the system known as *predator-prey*[44]. Let us imagine a lake inhabited by trout and sturgeon. The sturgeon, better known for the caviar, is a very greedy fish, which in its adult age reaches one meter and a half and whose favorite food is trout. During the first year in the lake system, and due to the great number of trout, sturgeon –which is not as abundant as trout - perceive the unlimited amount of food and they begin to grow and reproduce at the trout's expense. At that point, trout -being eaten by their predators- start to ravage. The lake is now abundant in sturgeon and scarce in trout; and therefore, the number of sturgeon dying due to lack of food increases.

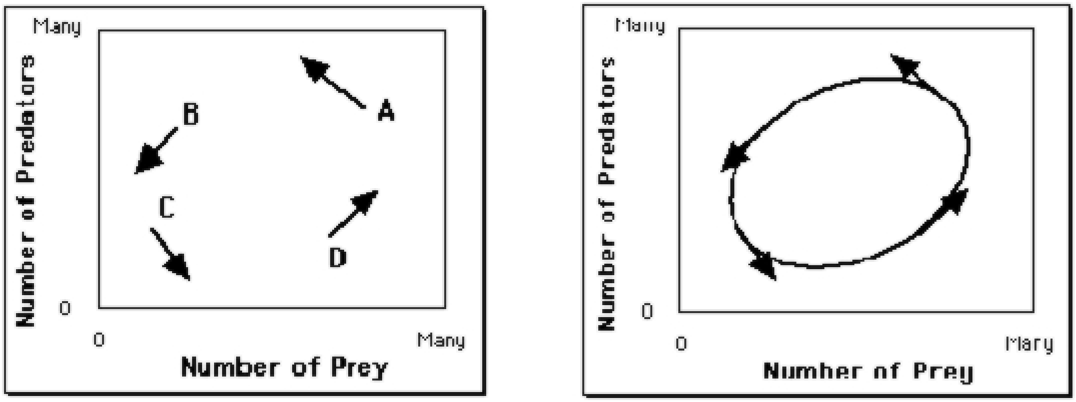
After some years, due to the decrease in the sturgeon population, trout live peacefully and multiply themselves. Consequently, the few sturgeons alive now count with plenty of food and multiply once again. Thus, an oscillation between the number of sturgeon and the number of trout -i.e. predators and prey- establishes a cycle, so that from time to time the number of sturgeon decreases while the trout population reaches a peak and vice versa.
The predator-prey system (known as "Lotka-Volterra") is a bi-dimensional system since it considers only two variables. Both variables grow, but one at the expense of the other[45].
In the following chart, y represents the number of predators and x represents the number of prey.

[42] Keith Clayton, "Basic Concepts in Non-linear Dynamics and Chaos" (Society for Chaos Theory in Psychology and the Life Sciences, Berkley, California, June 1996) http://www.vanderbilt.edu/AnS/psychology/cogsci/chaos/workshop/Workshop.html

[43] J. Briggs and F.D. Peat, *op.cit.*, page 34.

[44] J. Briggs and F.D. Peat, *op.cit.*, page 37.

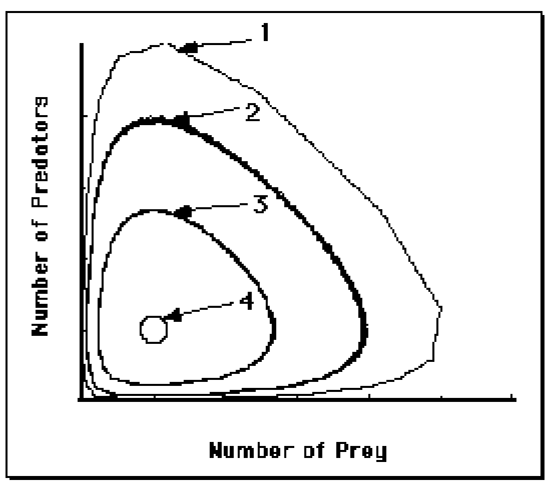
[45] Klaus Maizer, *Thinking in Complexity: The Complex Dynamics of Matter, Mind and Mankind*, (Berlin, Springer, 1997, 3rd edition), page 310.



Phase space of predator-prey system

Where:
A = too many predators
B = low amount of prey
C = some predators and some prey
D = few predators and high amount of prey (possible)
The (idealized) trajectory of the behavior showed by the trout-sturgeon system is a circle, an ellipse or another closed shape, i.e. a limit cycle attractor.

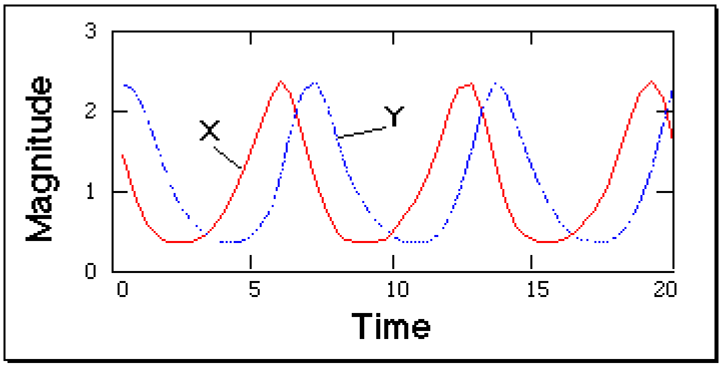
Different attractors will be obtained if we assume different starting point values (e.g. with different values for the number of predators).



Graph of predator-prey system with different initial states

Points 1 to 4 start with the same number of possible prey, but with different number of predators.
If the predator-prey system is viewed as a time series diagram, we will obtain two curves showing out-of-phase oscillations of prey and predator's populations' magnitude.

Scientists have carefully studied this predator-prey system and have demonstrated that if a number of trout is thrown into the lake at any time of the cycle, the numbers will finally adjust to follow the original cycle. If an illness eliminates trout, the population goes back to the cycle's limits. A combined predator-prey cycle of trout and sturgeon, or lynxes and hare-another typical example- has remarkably stable dynamics.



Predator-prey system's time series showing the cycle maladjustment

While the pendulum was a simple system, the predator-prey situation is much more complex. The system has a great number of individuals and each of them behaves randomly; however, they somehow create an organized and stable system throughout time.

A limit cycle is not always reduced to simple periodicity. There can be limit cycles that describe the system -an emergent- with three variables, trout, sturgeon and fishermen. In this case, the logistic map would be three-dimensional and the system's trajectory would have an "8" shape in the space.
On the other hand, two separated limit cycles interacting one with the other may be possible. To draw a chart, imagine the movement of two pendulums A and B, each with a propelling engine. If pendulum A is left aside, pendulum B's motion will show a simple limit cycle attractor as seen above. In addition, if pendulum B is left aside, A's movement will also show a simple limit cycle.
But if both pendulum interact, the size of the phase space increases and formerly independent limit cycles become chained. It is as if cycle A were prompted in a circle by cycle B.

A circle prompting another is the generation of a doughnut shape called torus by mathematicians.
Instead of two interacting pendulum, it could well be two predator-prey interacting systems. Thus, for example, the sturgeon-trout system could interact in the lake with an insect-frog cycle. When drawing this larger two-cycle system's dynamics we create a *torus attractor*.[46]

[46] Moisés J. Sametband, *op. cit.*, *page* 49.

3.4.3 Torus Attractor

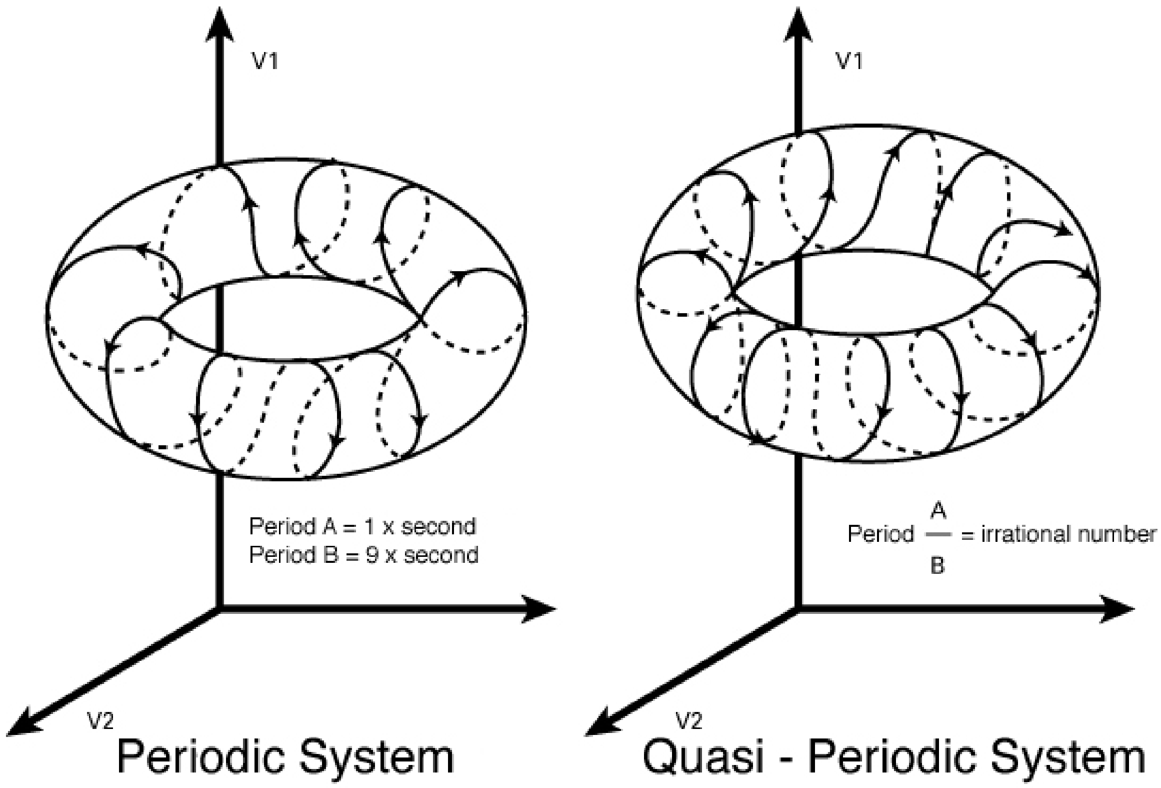
The phase-space where the torus attractor interacts is three-dimensional although mathematicians can work with torus in any number of dimensions.
To have an idea of a torus let us imagine a curled rod whose ends are connected, forming a ring.

The torus is also useful to represent a multi freedom system. A swinging pendulum has one degree of freedom. Now, let's imagine that its suspension system loosens so that it oscillates sideways and back and forth. In that case, the pendulum would not have one but two levels of freedom.
A two-level freedom system's oscillation can also be described as a point moving in the surface of a torus.
The combined movement of a pair of oscillators -pendulums, predator-prey cycles or planets- can be plotted as a line rotating around the torus, *showing that the surface of the torus is the attractor.*

If the periods or frequencies of the two coupled systems are in a simple proportion -e.g. if one doubles the other- the curves around the torus (the rib of a curled rod) are linked with precision, showing the precise periodicity of the combined system. In the case of a curled rod, the last loop would coincide with the first one when we connect the ends to form a ring.
There is also another form of coupled oscillatory behavior. In this case, the individual frequencies are not proportional but *irrational* ; as in positive or negative feedback, this is just a name rather than a judgement.

Rational numbers such as ½, ¼, ¾ and so on can always be expressed as a finite number of decimals (0.5; 0.25; 0.75) or as a recurrent simple decimal: 1/3 = 0.333333. In contrast, an irrational number cannot be transcribed as a proportion and its decimal expression contains an infinite number of terms with no recurrent pattern. The digits of an irrational number have a random order, as the value of π.
If the combined system forms an irrational frequency, the phase space point represented by the system rotates around the torus and never connects with itself (in the curled rod, the last loop would never coincide with the first one when we connect the ends). This system is called *quasi-periodic* since it looks "almost" periodic but in fact it is not because it is never repeated.

Mathematicians have demonstrated that there is an infinite number of rational numbers, but there is an infinitely larger number of irrational numbers, so that it seems that quasi-periodic systems dominate the universe.



The nature of attractors is very regular. Systems smoothly fall before fixed-point attractors or oscillate in soft limit cycle attractors around a torus-like shape.

The notion of *asymptotic predictability* refers to the fact that although researchers ignore the precise position of a system at a certain moment, they are confident that the system will move on the torus surface rather than wander randomly in the phase space regardless of how far they investigate in the future.

Self-similarity, analyzed in detail later, means that the behavior of any natural or social system, including individual human beings, may be similar from day to day, year to year, or tion (or iteration of any given system) is precisely like a previous embodiment. Thus, variation is the natural state of social forms that take the geometry of a torus; self-similarity comprises first order change found in all interactional processes, in all cases of crime, in all worship services, and in all forms of business activity.

As described in fractal geometry, each succeeding cycle of a torus builds up a portrait of self-similarity in that there is a loose approximation of one cycle of behavior to the previous cycle. Thus, in a baptism, a marriage, a funeral, or a mass, however experienced the priest is, however formal the ritual is, however skilled the communicators are, still no given cycle of religious service is precisely like another. The same thing is true in any given social act one might wish to examine, even in the most stable and enduring of societies. In any given social role, in any given social occasion, or in any given embodiment of a classroom lecture, self-similarity displaces sameness. Whatever pattern is found in social life, it is there because sentient human beings work hard to create one iteration of an occasion in the image of a previous cycle. Human actions entail variety.

According to Young: *It is here that individual judgement can cope with exigency; it is here that individual creativity can assert itself within the limits loosely defined by external*

parameters: food supply, cultural values, social controls, social esteem, and interpersonal dynamics. But do note that, while there is uncertainty about the life course of any given marriage in a simple agrarian political economy, all marriages will fall within the boundaries of the torus ... in that, there is a great certainty. If one does not respect the norms of food preparation and usage, hunger awaits. If one does not respect the norms of property holding and property transfer in settled agrarian society, poverty awaits. If one does not observe the norms of sharing and caring, mutual aid is foresworn."[47]

Each marriage has a similar beginning, waves along loosely around given norms: for example, norms about how to organize gender relations, child rearing practices, size of family, frequency of visiting kin, fidelity to the spouse, or whatever else is of interest to the researcher and found to be part of the ways of marriage in a culture. Variations outside the fractal boundaries of the torus are damped out by negative feedback in the larger environment. If several such marriages in the same culture are superimposed on each other, one can begin to see a normative pattern emerge. This is the beginning of customary law. After thousands of iterations of marriage forms over dozens of generations, the idea of normal and abnormal emerge as an emerging property of the system.

Ordinarily, we do not think in term of a torus since most researchers takes slices of the marriage form or of hundreds of marriages at one point in time. This practice reduces a three-dimensional dynamical form to a two-dimensional static form. Ideas of normality and eternality thus are left to a second category.

Self-similar systems, such as in a torus, exhibit close-to-stable dynamics. In the observations of thousands and millions of iterations of natural and social systems, a structure emerges; that structure is a chain of small variations with infinite variety, infinite length, and infinite detail rather than a stable, natural pattern. Modern research designs can pick up distributions around a certain norm but, in the sectioning of a much more dynamical process, lose the larger pattern of change and renewal.

Just as no two marriages are identical, no two meetings of a classroom or a conference are precise iterations of each other. This similarity, but not sameness, is of special interest to deviancy theory. It sets variations as the nature of the social process rather than conformity. These small and local variations, under some conditions, amplify and transform into much more complex patterns.

Most sociological theories of order place great emphasis on socialization and social controls, as well as on magical but quite human processes in which things defined as true become true in the consequence: the self-fulfilling prophecy. Again, the process does not fulfill itself; sentient human beings do the necessary work of trusting, believing, and acting as if something quite problematic would indeed become real. Social science based on complexity and chaos theories, instead, uses the concept of causality in which one variable changes another; complexity theory makes great use of the concept of feedback to explain systems of both stable and changing social dynamics.

The source of semi-stable order of a social torus is to be found in non-linear feedback. Unrestrained, positive linear feedback drives systems into deep chaos; negative linear feedback tends to restrict creativity and innovation. If we want to maintain the integrity of any given social form, then there must be some form of social response with which to defeat the transformation of the torus into a butterfly attractor. In human affairs, this requires forgiving, forgetting, and treating incompatible events as if they had never

[47] T.R.Young, *Chaos Theory and the Knowledge Process: Exploration in Post-modern Methodology*. (Michigan, The Red Feather Institute, 1993).

happened and, in general, a continuous and expert editing of the reality process as it unfolds. In everyday interaction burps, belches, grunts, sneers and shrugs are treated as if they did not occur. More serious defects are registered on human consciousness but defined as “not really” there. Infidelity in marriage, dishonesty of employees, contempt of students, disobedience of soldiers, and heresy in the priesthood are usually defined non-linearly ... as noise in the system.
The curious thing is that, if we want to resist change, we must couple one kind of change with another[48]. With recourse to non-linear and qualitative change, it is possible to institute a stability that relies upon instability. The curious feature of ultra-stable systems depends upon non-linear change[49].
The effort to conserve traditional structures in times of great uncertainty depends more heavily on change than on repressive social control tactics since, to paraphrase H. Ross Ashby, only chaos can cope with chaos[50]. In a concrete case, if we want to maintain the integrity of the nuclear family in the social, cultural, and economic conditions of the 90’s, we must innovate. New ways of doing childcare, new ways of doing food preparation, and new ways of organizing education and religion are required. Instead of health care, child care or housing apportioned to each family in terms linear to their income -poor families having poor housing, health care, or child care, while rich families have interactionally rich child care, informationally rich health care, or just plain rich housing- non linear processes of distribution must occur for the poor family, or else the family falls apart; children wander off, spouses separate, and landlords evict.
The analysis of a social torus can derive in useful patterns to design innovative policies. If we want to design a low-crime society, then we may have to make qualitative changes in quite ordinary practices. Corporate crime, white-collar crime, organized crime, as well as street crime explode when key variables exceed given limits. Key variables include inequalities in class, race, and gender relations. It may well be the case that some inequality in wealth is helpful to the economic life of a nation; Plato suggested a four to one ratio, but it is likely that larger ratios set the stage for a wide variety of corporate and political crime for those at the top of the pyramids of power, while street-crime and organized crime become attractive for those at the bottom of such pyramids. White-collar crime may begin to be interesting to rich and poor alike who live on the cusp of financial uncertainty.

3.4.4 The Butterfly Attractor

In his work *Science and Method* (1908), the great mathematician Henri Poincaré wrote: “*a very small and unperceived cause determines a considerable effect that we cannot but perceive and we therefore attribute it to randomness. Why is it so difficult for meteorologists to forecast the weather with some degree of certainty? Why do we think that rain and tempests appear randomly, so that for many people it is natural to pray for rain or good weather while it would sound ridiculous to pray for an eclipse? We can see that great perturbations are generally produced in regions where the atmosphere is in*

[48] J. Briggs and F.D. Peat, *op.cit.*

[49]T.R.Young, *op. cit.*, 1993.

[50] W.R. Ashby, *An introduction to Cybernetics*, (New York, John Wiley & Sons, 3rd ed. 1968).

unstable equilibrium. Meteorologists see that this equilibrium is unstable, and they know that a tornado will take place somewhere ... but where? They cannot give an answer: a difference of a tenth of a degree at any point will determine that the tornado will strike here and not there and it will spread over locations that would not have otherwise been devastated. If such a difference in the degrees had been know, it would have been possible to anticipate the damage; but observations were neither rigorous nor precise enough and therefore everything seems to be due to the intervention of randomness."[51]

The behavior of weather has always intrigued researchers; so, it is no surprising that the first true experimenter in chaos was a meteorologist, named Edward Lorenz. In 1960, he was working on the weather prediction issue. He had a computer set up with a set of twelve equations to model the weather. The computer did not predict the actual weather, though; it theoretically predicted what the weather might be.

One day in 1961, he wanted to see a particular sequence again. To save time, since computers were incredibly slow by then, he started in the middle of the sequence, instead of the beginning. He entered the number off his printout and left to let it run. When he came back an hour later, he was surprised to verify that the sequence had developed differently. Instead of the same pattern as before, a totally divergent pattern, wildly different from the original had appeared. Eventually he figured out what had happened: the computer stored the numbers to six decimal places in its memory. To save paper, he had arranged the machine so as to print out only three decimal places. In the original sequence, the number was .506127, and he had only typed the first three digits, .506.

According to conventional ideas at the time, it should have worked. He should have obtained a sequence very close to the original sequence. A scientist considers himself lucky if he can get measurements with accuracy to three decimal places. Surely the fourth and fifth, impossible to measure using reasonable methods, should have had an insignificant effect on the outcome of the experiment. Lorenz proved this idea wrong. This effect came to be known as the *butterfly effect* and it is expressed with a parabola: *the flapping of a single butterfly's wing in the Indonesian forest may produce a tornado on the Atlantic coast of the United States.* Why? Because the flapping of the butterfly produces a tiny molecular change in the state of the atmosphere and as a result of this over a period of time, the atmosphere ends up doing something completely different from what it might have done. Therefore, what was going to happen does not, or vice versa[52].

This phenomenon, common in chaos theory, is also known as *sensitive dependence on initial conditions*. Just a small change in the initial conditions can drastically change the long-term behavior of a system. The smallest difference in a measurement might be considered experimental noise, background noise, or an inadequacy of the equipment. Such things are impossible to avoid even in the most sophisticated lab. The final results from the same system can differ entirely with a starting number of 2 from the results with a starting value of 2.000001. In practice, it is impossible to obtain empirical data to construct models with a level of accuracy of a millionth.

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[51] Henri Poincaré, *Science et Méthode* (París, Flammarion, 1908). Cited by Moisés J. Sametband, *op. cit., page* 34.

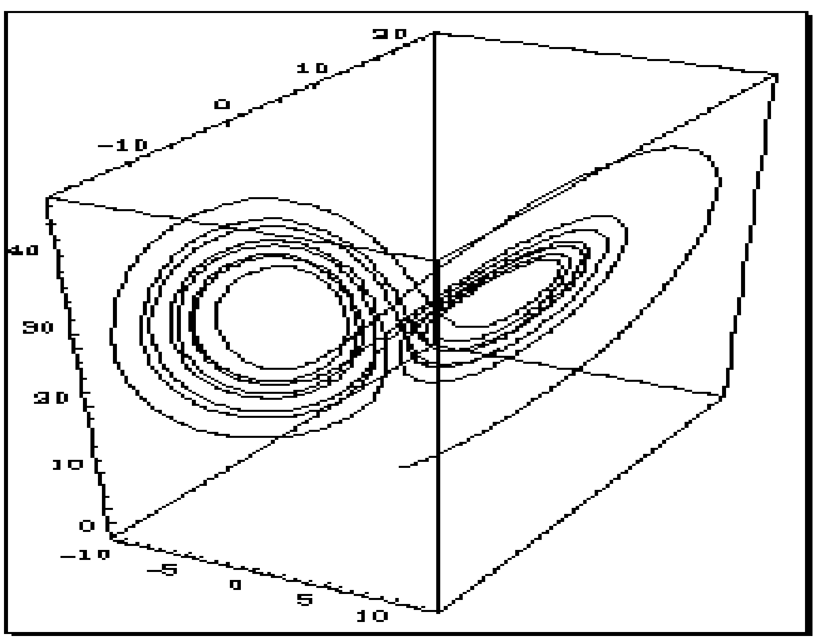
[52] Ian Stewart, "Does God Play Dice? The Mathematics of Chaos" in *Chaos Theory: a Brief Introduction*: http://www.imho.com/grae/chaos/chaos.html

Lorenz started to look for a simpler system that had sensitive dependence on initial conditions. His first discovery had twelve equations, and he wanted a much simpler version that still had this attribute. He took the equations for the mathematical model for atmosphere convection, and simplified them, making them unrealistically simple. The system no longer had anything to do with the convection, but it did present with only three equations sensitive dependence on its initial conditions. Later, it was discovered that his mathematical model described precisely a hydraulic wheel: "*At the top, water drips steadily into containers hanging from the wheel's rim. Each container drips steadily from a small hole. If the stream of water is slow, the top containers never fill fast enough to outpower friction, but if the stream is faster, the weight starts to make the wheel turn. The rotation might become continuous. If the stream is too fast that the heavy containers swing all the way around the bottom and up the other side, the wheel then slows down and eventually stops and reverses its rotation, turning first one way and then the other and so on.*"[53] .

The equations for this system appeared to demonstrate an entirely random behavior. However, when he plotted it, a surprising thing happened: the graph always described a curve, a double spiral.

Up until then, only two kinds of order were known: a stable state, in which the variables never change, and a periodic behavior, in which the system goes into an infinite self repeating loop. Lorenz's equations are definitely orderly, since they always followed a spiral. They never settled down to a single point, but since they never repeated the same pattern, they were not periodic either. He called the image he got when he plotted the equation *the Lorenz attractor*; however, the popular name was *butterfly attractor* because of its shape.

As time went by, other experiments showed that two tori attractors can be united in a butterfly attractor.



Lorenz's butterfly attractor

[53] "The Lorenzian Waterwheel" in *Lorenz Attractor:* http://www.students.uiuc.edu/~agho/chaos/lorenz.html

In 1963, Lorenz published a paper describing what he had discovered. He included the unpredictability of the weather, and discussed the types of equations that caused this type of behavior. Unfortunately, the only journal he was able to publish it in was a meteorological journal, because he was a meteorologist, not a mathematician or a physicist. As a result, Lorenz's discoveries were not acknowledged until years later, when they were rediscovered by others. Lorenz had discovered something revolutionary; now he had to wait for someone to discover him. [54]

3.4.5 Strange Attractor

In the 19th century, the prevailing idea was that chaos and regular order had little in common. In fact, they were believed to be opposite. However, chaos is not mere oscillation without course but it is a subtle form of order.
Chaos is most paradigmatically pictured through turbulence; it is present in all orders of nature: air droughts, deep rivers or a mob. Turbulence destroys orderly systems and fills them with disorder. The study of turbulence, a discipline of the increasing field of chaos, is currently based on liquids and gases.
This interest in systems with so many levels of freedom and with such complex dynamics derives from the technology developed in the field of sensors and the possibilities made available by super-fast computers that are capable of mapping the results of equations representing turbulence. Nowadays, researchers can project the visual displays in "slow motion" and reproduce processes that take place within the turbulent movement.

A good example is what happens in a fluidly flowing stream. The different parameters describing the flow are constant and immutable. Even when the stream is disturbed by throwing a stone into it, it quickly returns to its normal flow. When the variables of the stream flow do not change, the water that runs undisturbed can be represented by a single point in the phase space, thus obtaining a point attractor. In this case, the point represents the constant speed of the water.
When the current is more rapid, the flow gets distorted due to oscillations forming stable vortex, i.e. whirls that are fixed in one point. This flow is still very regular and can be characterized as a limit cycle. The stream disturbed by a stone always returns to the same basic oscillation, the same stable vortex.
A point attractor can describe the movement when the speed of the flow is slow but, as it increases, a limit cycle attractor is formed.

When the stream finds obstacles and sharp slopes, "rapids" are generated; in it, the water region behind each rock seems to have lost order and the measurement of the flow ratios show chaotic results. Turbulence prevails, and the movement of each water molecule seems to be random. The region has so many levels of freedom that the possibilities of describing it exceed the scope of current science.
Vortexes in the rapids tend to break down into smaller ones, which in turn break down again. The process leading to turbulence seem to involve continuous divisions and sub-divisions or *bifurcations* in increasingly smaller scales. This concept of vortex within vortex (ad infinitum) suggests that systems close to turbulence look self-similar in increasingly

[54] "History of Chaos" in *History of Chaos:* http://tqd.advanced.org/3120/text/c-hisl.htm

smaller scales. This characteristic of *self-similarity* is the quintessence of *fractal geometry*, as will be seen later[55].

For physicist Lev Landau, a new disturbance in the flow introduces another oscillation that will lead to a four-dimension phase space representation, and so on until reaching chaos; there is a high number of dimensions that correspond to the high number of independent variables of the turbulent flow[56]. Instead, according to mathematicians David Ruelle and F. Takens [57], chaos is produced abruptly and much earlier: when the two simultaneous oscillation frequency whirlpool is disturbed. This is not visualized through a new four-dimension figure in the phase space but by radically altering the shape of the attractor on the torus surface. The resulting figure is so strange that Ruelle called it *strange attractor.* Although some authors call it *chaotic attractor, strange attractor* was the name adopted by researchers to describe attractors indicating a long-term non linear unpredictable behavior, whose chaotic pattern needs an infinite line since it never goes through the same point twice but its path goes on indefinitely within a definite area. Attractors are defined as *strange* because "they describe systems that are neither static nor periodic"[58].

In this way, strange attractors were born as mathematical terms that helped explain why the cigarette smoke draws patterns, i.e. circles in the first puff, and why flooded water finds it point of flux and reflux. Their analysis rapidly spread to other fields such as astronomy to understand Jupiter, economy for the study of recession, and medicine for the study of epilepsy, heart attacks, cancer cells, antidepressants effect, breathing disorders and white cell regulation. Epidemiologist William Schaffer discovered that infants' mumps spread varies in connection with a strange attractor. Scientists have developed a computer program to define whether there is a strange attractor representing hidden patterns behind apparently random and chaotic information that indicates the dynamical change in a complex system.

In essence, a strange attractor is the process that appears through complex interactions between the elements of a system[59]. Some think that they are the base of some hidden order of natural systems. Although chaotic systems oscillate erratically, they stay within a specific range or standard. When data from strange attractor points are mapped, they often resemble an infinite a complex drawing.
Although there is an apparent order in the pattern, the system is chaotic because the orbits around the attractor points are never exactly repeated. This phenomenon is common to systems that work following chaotic principles: as data are accumulated along time, they

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[55] Glen Elert, *Chaos, Fractals, Dimensions: Mathematics in the Age of the Computer*, (1995-1997) in http://www.columbia.edu/~gae4/chaos/cfd.1.1.html

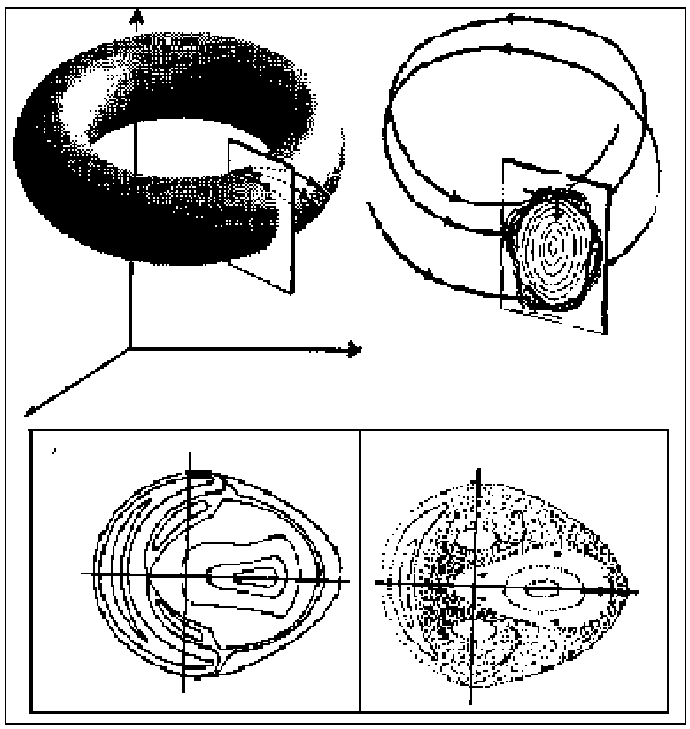
[56] J. Briggs and F.D. Peat, *op.cit*, 49-50.

[57] J. Briggs and F.D. Peat, *op.cit*, 50-51.

[58] B.A. Stevens, "Chaos: A Challenge to Refine Systems Theory", *Australia & New Zealand Journal of Family Therapy* (12-1, 1991), pages 23-26, cited in Robin Robertson and Alan Combs(editors), *Chaos Theory in Psychology and the Life Sciences*, (op. cit.), page 267.

[59] Linda Chamberlain in: Robin Robertson and Allan Combs (editors), *Chaos Theory in Psychology and the Life* Sciences, (op. cit.), page 268.

appear in order but they are unpredictable from one moment to the next. Chaos is a science of patterns, not of predictability.
When analyzing the apparent range limiting function for behavior of strange attractors in a system, DiBello noted: "*A strange attractor acts like a magnet restricting systemic variables within given ranges*"[60]. Although strange attractor patterns are never repeated identically, they somehow limit the system's activity. Butz summarizing the concept and established that "*an attractor is simply what the word sounds like, something that attracts this or that*"[61].
Their non-linear and fractal nature differentiates them from other types of attractors, i.e. fixed point and limit cycle attractors.
When a strange attractor's torus is cut, as a doughnut slice known as *Poincaré's section,* we can notice its fractal structure: the former bi-dimensional attractor jumped to a dimension higher than 2 and lower than 3.



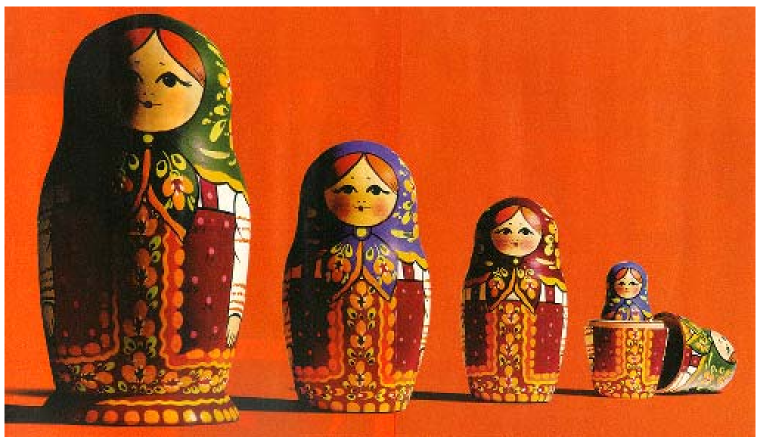
Strange attractor section of a and detail of Poincaré's section with its patterns.

[60] R. DiBello, "Personality as a Strange Attractor", *The Social Dynamics (December 1990)*, page 1, cited in Robin Robertson and Alan Combs (editors), *Chaos Theory in Psychology and the Life Sciences,* (op. cit.), page 268.

[61] M. Bütz, *Chaos Theory, Psychology's New Friend?* (Unpublished manuscript, 1992), cited in Robin Robertson and Alan Combs(editors), *Chaos Theory in Psychology and the Life Sciences,* (op. cit.), page 268.

An important aspect of Ruelle-Takens[62] finding is that it shows that a dynamical system formed by a large group of elements can reach chaotic behavior starting from three levels of freedom. Before that, it was thought that, as common sense seems to indicate, chaos can only exist when the system has a great number of independent variables.

A thorough analysis of the variety of strange attractors showed that they all shared a number of characteristics. Their shape is somehow stable and it can be demonstrated within a limited space. Strange attractors show self-similarity in descending scales even though they are never repeated, like a set of Russian dolls, i.e. each of them contains a smaller copy of itself. The attractor's self-similarity has no end. It is endless. It is possible to expand the image as much as you wish and you will always find an even smaller copy. The shapes of strange attractors are fractals. A strange attractor is an object that reveals more detail as it is magnified.



Self-similarity in Russian dolls: one is identical to the other but in different scales.

What happens when the concept of a strange attractor is used to study human dynamical systems? The theory has been applied to many areas of social science, such as psychiatry, psychology and sociology, including studies about changes ranging from patients' mental states during psychotherapy [63], daily mood fluctuations [64], the study of personality[65], to the autogenesis of the self[66]. As Stevens [67] stated, "*Even in the most*

[62] D. Ruelle and F. Takens, "On the Nature of Turbulence", *Communications Math Physics*(20: 167, 1971), page 92, cited in Douglas L. Kiel and Euel Elliot (editors), *Chaos Theory in the Social Sciences: Foundations and Applications*. (EEUU, University of Michigan Press, 1996), page 55.

[63] D. Pendick, "Chaos of the Mind", *Science News* (143, 1993), pages 138-139, cited in Robin Robertson and Alan Combs(editors), *Chaos Theory in Psychology and the Life Sciences*, (op. cit.), page 269.

[64] T. Hanna, "Does Chaos Theory Have Applications to Psychology? The Example of Daily Mood Fluctuations, *Network*, (Fall 1990), pages 13-14, cited in Robin Robertson and Alan Combs(editors), *Chaos Theory in Psychology and the Life Sciences*, (op. cit.), page 269.

[65] R. DiBello, "Personality as a Strange Attractor", op. cit., cited in Robin Robertson and Alan Combs(editors), (op. cit.), page 269.

chaotic of family situations there may be organizing principles." It is the patterns of organizing principles or behaviors that constitute the strange attractors in families and provide stability when the family is in danger of going outside the limits.
Gampel[68] wrote that "*when we are drawn to another, perhaps as being drawn to another attractor, with great intensity, we transform as we fall in love and risk the dissolution of our boundaries in the merger*". She describes the pull of the strange attractor as the familiar conflict between solitude and intimacy in a relationship. Strange attractors are even appearing in popular literature. In the story titled *Ten Laws of Lasting Love*[69], Paul Pearsall introduced his readers to the world of strange attractors. He described love as the product of two personal "strange attractors" drawn to each other to make windows through the chaos of living. He hypothesized that most couples view life's chaos as an obstacle in their quest for self-fulfillment; for them, the necessary turmoil of life is a barrier. But those who have reached the level of "high monogamy" see chaos as a necessary and natural life process. According to Linda Chamberlain, author of *Strange Attractors in Family Interaction Patterns*[70], most family therapists have in fact experienced the phenomenon of the inability to predict from one session to the next how a conflicted couple will behave and the ability to discern certain patterns over time. Despite the appearance of chaos in relationships, there are certain boundaries that limit behaviors.

Although the concept of duality is inexorably embedded in the definition, strange attractors are not simply bi-dimensional (e.g. solitude versus intimacy). Particularly in the realm of human relationships, even the most basic two-person relationship includes the two as a couple, each as individual, and each as a product of his or her own family and social experience. In the case of a couple, there is not just the conflict between the partners with regard to intimacy and distance, but also within each partner at any given time. The desire for greater closeness or separateness is experienced on both an individual and relationship level and is further complicated by the unremitting influence of environmental factors that enter the pattern. Chubb noted "*The fact that chaotic interactions occur between individuals while other interactions, nonlinear and therefore also chaotic, are occurring within the social organizations, adds an extra measure of complexity to the study of social systems because it also contributes to the inherent unpredictability of human relationships. It is the interaction of diverse attractors at different levels of organization that*

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66 M. Schwalbe, *The Auto-genesis of the Self,* (Paper presented at the Southern Sociological Society Convention (Louisville, KY, March 1990), cited in Robin Robertson and Alan Combs(editors), (op. cit.), page 269.

67 B.A. Stevens, "Chaos: A Challenge to Refine Systems Theory" (op. cit.), cited in Robin Robertson and Alan Combs(editors), (op. cit.), page 269.

68 D. Gampel, *Fractal Selves, the Fragility of Relationships and Chaos Theory* (Paper presented at the Society for Chaos Theory in Psychology Convention, San Francisco, Cal., August 1990), cited in Robin Robertson and Alan Combs(editors), (op. cit.), page 269.

69 Paul Pearsal, *Ten Laws of Lasting Love* (New York, Simon & Schuster, 1992).

70 Linda Chamberlain, "Strange Attractors in Patterns of Family Interaction" in: Robin Robertson and Allan Combs (editors), *Chaos Theory in Psychology and the Life Sciences*, (op. cit.), page 267.

give us the richness and diversity seen both in strange attractor patterns and in family relationships[71].

In his work *A Model of the Mind as Dynamical System*, the American psychoanalyst Michael Moran[72] explains that the psychoanalytical models of the mind can be viewed as non-linear dynamical systems. A patient under treatment has a mental state that experiences several interactions, e.g. the feelings and emotions, the verbal associations, the figure and participation of the psychoanalyst, the physical experience of lying on a couch and other effects. These interactions do not count when describing the mental state of the patient, but they influence each other and determine the state of his dynamical system. In addition, says Moran, there is a strong and sometimes sensitive dependence on initial conditions. To a great extent childhood experiences determine the present in a deterministic but unpredictable sense due to complexity.

Also in mental processes it is possible to find patterns that repeat themselves in a continuous but never periodically identical way. In addition, in these patterns, in these strange attractors, "*there is a scale effect in fractal structure: we can characterize seemingly small actions, observations or a single dream in mental processes in micro-scale where the fundamental structure is exhibited in small things.*"[73]
Moran compares the strange attractor concept and the patient's fixed collection of unconscious fantasies about himself and his surrounding environment. In the psychoanalyst observation and research, regardless of how complex the patient's behavior is, this collection of unconscious fantasies always play a major role. This strange attractor is very complex. Only a small portion of the attractor may be repeatedly revisited by the dynamical system's solution, while the rest is ignored. Since the strange attractor represents the unconscious collection of the patient's fantasies, the dynamics may cause serious trouble. Think of a paranoid state of the mind or a compulsive repetition of actions and behaviors that imply a remarkable lack of freedom. In that case, the unconscious dynamics is dominated by part of the recollection of unconscious fantasies. Conspiracy theories, which will be analyzed in chapter four, constitute a strange attractor in the mind of paranoid individuals.

Moran is convinced that if this similarity between nonlinear dynamical systems and mental states is correct, the chaos theory may be applied to psychoanalytic treatment. According to Verhulst, "*a patient may be driven to actions such as washing his hands frequently. This may be a reaction to strong internal conflicts. They can derive from a strong aggressive impulse with the corresponding anxiety and its prohibition. Anxiety here becomes hosophobia and hand washing represents the solution for the patient. This leads to lack of freedom and space in the personal life of the individual; it results from an unconscious fantasy that is attractive and frightening at the same time, and thus, repulsive. In this way, the symptom -frequent hand washing can be a compromise between contradictory and*

[71] H. Chubb, "Looking at Systems as Process", *Family Process* (29, 1990), pages 169-175, cited in Robin Robertson and Allan Combs (editors), *Chaos Theory in Psychology and the Life Sciences*, (op. cit.), page 269.

[72] Michael G. Moran, "Chaos Theory and Psychoanalysis: the Fluidic Nature of the Mind", *International Review of Psychoanalysis,* (Nº18, 1991) pages 211-221, cited in "Metaphors for Psychoanalysis", *Non-linear Science Today*, (Springer- Verlag, Vol. 4 Nº 1, 1994), pages 3-4.

[73] Michael G. Moran, op. cit.

conflictive tendencies. The strength of this process originates frequent repetitions as well as lack of freedom"[74]. As regards the chaos theory, this means that its strange attractor contains a small sub-group visited by solutions with relative frequency. From this viewpoint, says Verhulst, an adequate treatment may consist in changing -through timely perturbations- the link between this active part of the patient and his mind as a whole, and therefore, the corresponding pattern of behavior. If these perturbations persist, the orbit pattern becomes more complex; other parts of the strange attractor will be visited more frequently and this results in a behavior with a greater variety of patterns (more "normal").

As shown in the preceding analysis, the strange attractor is a determining force for mind-connected activities. As in any chaotic system, the individual's behavior is unpredictable. The limit of this unpredictability is the collection of unconscious fantasies typical for each specific individual. We do not expect arbitrary behavior from normal individuals since their strange attractor' structure limits the erratic or seemingly random behavior.

3.5 Fractal Geometry

Until 1975, we did not have a fractal geometry. Our only geometry was the familiar Euclidean geometry, which goes back over two thousand years. The *elements* of Euclid (circa 300 BC) summarized in thirteen volumes the mathematical knowledge of ancient Greece. Up into our own century, Euclid's books of geometry were taken as the final, authoritative word on the subject. Euclidean geometry deals with whole rather than fractional realities. Plane geometry concerns *planar* (one- and two- dimensional) structures, and solid geometry describes three-dimensional structures.

According to Gleick[75], "*new geometry always begins when someone changes a fundamental rule. Suppose space can be curved instead of flat and the result is a weird curved parody of Euclid that provides precisely the right framework for the general theory of relativity. Suppose space can have four dimensions, or five, or six. Suppose the number expressing dimension can be a fraction ... suppose shapes are defined, not by solving an equation once, but by iterating it in a feedback loop.*"
The French mathematician Benoit Mandelbrot[76] made a number of the above suppositions, and the result was the birth in 1975 of "fractal" geometry and mathematics (fractional).
Benoit Mandelbrot was working at IBM on the problem of noises in the form of static bursts that interfered with hearing on telephone lines. Confronting the problem, Mandelbrot found

[74] F. Verhulst, "Metaphors for Psychoanalysis", *Non-linear Science Today*, (Springer- Verlag, Vol. 4 Nº 1, 1994), pages 5.

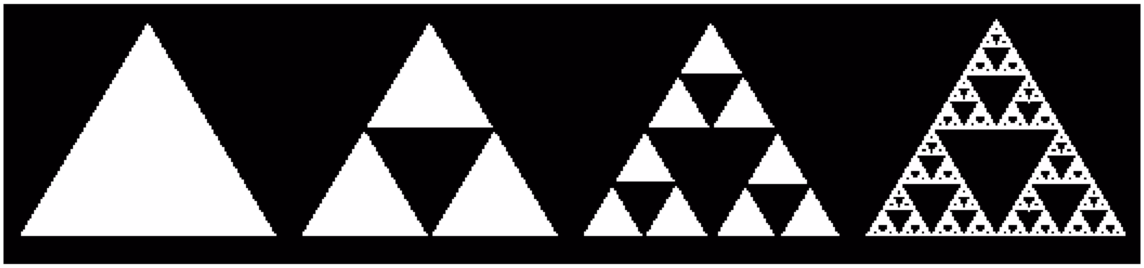
[75] See the following works:
J. Gleick, *Chaos: Making a New Science*, (New York, Penguin Books, 1987)
J. Gleick, *Chaos*, (Cardinal Books, 1991).
IN connection with Fractals, see: http://www.vanderbilt.edu/AnS/psychology/cogsci/chaos/workshop/Workshop.html

[76] To find information on Mandelbrot, see: Keith Clayton, "Basic Concepts in Non-linear Dynamics and Chaos" (Society for Chaos Theory in Psychology and the Life Sciences, Berkley, California, June 1996)
http://www.vanderbilt.edu/AnS/psychology/cogsci/chaos/workshop/Workshop.html

that whatever time scale he used -hours, minutes or seconds- he always found the same ratio of noise to noise-free transmissions. The behavior of the static was always the same on any scale. He had discovered similar degrees of irregularity (static bursts) across different scales. He was used to thinking in terms of figures and shapes and he began to create geometric forms to represent the characteristics of these transmissions. The forms he drew had the property of self-similarity across scales. They maintained a similar proportion of disorder (irregularity) to order (regular transmissions) on whatever scale they were measured. Mandelbrot named these forms *fractals* from "fractus" meaning "broken" or "to break". A new geometry was born. It was not the regular Euclidean geometry of straight lines and perfect circles. But it was a geometry that could depict the natural forms of nature such as clouds, mountain ranges, and coastlines and the forms of life such as trees and the nervous system.

3.5.1 Serpiensky Triangle

Fractal objects show several interesting properties. One of them, as we said before, is self-similarity. The Serpiensky triangle is a good example. It is composed by triangles, each of which is composed by smaller triangles, and so on. A fractal object like this shows self-similarity in many scales of observation. Another property of fractal geometry is the lack of a well-defined scale, e.g. clouds which tend to look very similar in appearance regardless of their size. The human body's arteries, veins, parotid gland ducts, and the bronchial tree all show some type of fractal organization. Fractals can also be found in surfaces of proteins, or in the distribution of arthropod body lengths.



Serpiensky's Triangle[77]

A popular example of fractals is a tree. While its branches become smaller, each of them shows a similar structure to the bigger branches and to the tree as a whole. Similarly, prices in the stock market show a structure of similar appearance in the daily, weekly and monthly charts. As in natural objects, as we get closer we can see more details.

The original stimulus after Mandelbrot's work was the interest in irregular patterns (seemingly chaotic): cotton prices along a long period, the frequency of earthquakes, flooding conditions, etc ... everything seemed to occur with regular irregularity. According to Gleick, Mandelbrot's studies of *irregular patterns* and his exploration of infinitely complex shapes had an intellectual intersection: a quality of self-similarity.

[77] Ibid.: http://www.vanderbilt.edu/AnS/psychology/cogsci/chaos/workshop/Workshop.html

At a certain moment, Mandelbrot posed a simple question: How long is the coast of Britain? His mathematical colleagues were miffed, to say the least, at such an annoying waste of their time on such insignificant problems. They told him to look it up. Of course, Mandelbrot had a reason for his peculiar question. Quite an interesting reason. Look up the coastline of Britain yourself in some encyclopedia. Whatever figure you get, it is wrong. Quite simply, the coastline of Britain is infinite. [78]

You can protest that this is impossible. Well, consider this. Consider looking at Britain on a very large-scale map. Draw the simplest two-dimensional shape, possibly a triangle, which circumscribes Britain as closely as possible. The perimeter of this shape approximates the perimeter of Britain. However, this area is of course highly inaccurate. Increasing the amount of vertices of the shape going around the coastline, and the area will become closer. The more vertices there are, the closer the circumscribing line will be able to conform to the dips and the protrusions of Britain's rugged coast.

There is a problem, however. Each time the number of vertices increases, the perimeter increases. It must increase, because of the triangle inequality. Moreover, the number of vertices never reaches a maximum. There is no point at which one can say that a shape defines the coastline of Britain. After all, exactly circumscribing the coast of Britain would entail encircling every rock, every tide pool, and every pebble that happens to lie on the edge of Britain. Thus, the coastline of Britain is infinite.

As seen above, self-similarity is symmetry across scale. It implies recursion, pattern inside a pattern. Mandelbrot's price charts and river charts displayed self-similarity, because not only did they produce detail at finer and finer scales, but they also produced detail with certain constant measurements.

From fractal forms it was not far to accept a fractal dimension, which represented the degree of irregularity of an object. It can also be seen as the measure of the relative degree of complexity of an object and the degree to which it fills up the space at its disposal. The degree of irregularity corresponds to the efficiency of an object in taking up the space it occupies. When comparing the degrees of irregularity of one object to another, you obtain their fractal dimensions. A tire's irregularity could be matched with the irregularity of the roads it could travel.

Mandelbrot began looking for data on systems that could be measured by the self-similarity of fractals. He searched for recursion of form and repetitiveness of patterns inside patterns. He found this self-similarity in the ebbs and flows of rivers such as the Nile, on which there are data for hundreds of years. He found the repetitive patterns within patterns displaying both persistence and discontinuity in the prices of commodities.

In 1983, Mandelbrot wrote that mathematicians would be delighted to find that fractal forms were not exceptional, they were the rule; that forms that appeared pathological should develop naturally from every concrete problems, and that the study of forms in nature could help solve old problems and simultaneously yield many new forms.

Other scientists from different disciplines found fractal forms and patterns in their fields. Fractals could be used to describe the appearances and properties of a variety of materials such as mental fractures and polymers. Doctors began using fractals to study heart attacks. In addition, the wake of an airplane, the study of an earthquake, the seeping of oil, some problems of nuclear reactors could be better understood using fractals.

Natural objects, other than man-made objects, seldom fill their available space. They may appear to be solid, but in effect they are not so. The measure of their fractality is the

[78] Ibid.: http://www.vanderbilt.edu/AnS/psychology/cogsci/chaos/workshop/Workshop.html

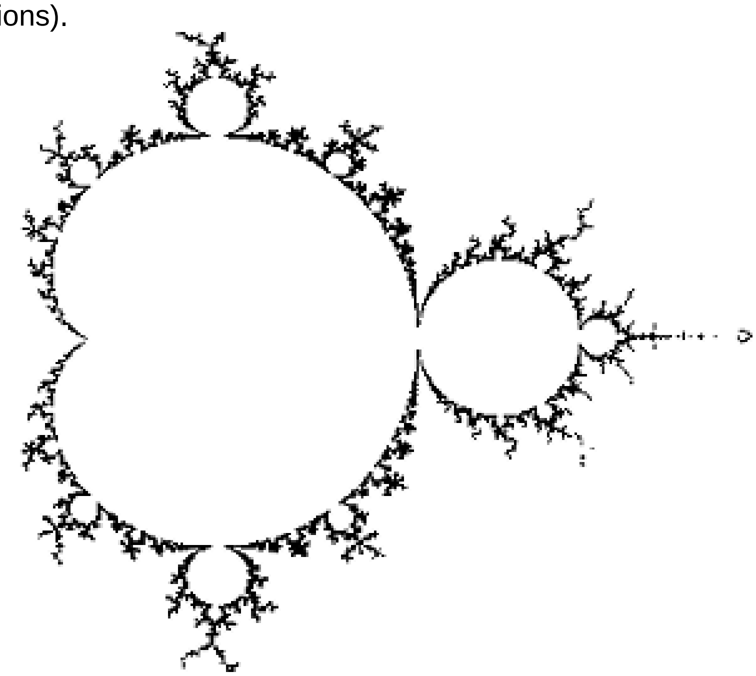
degree to which they occupy the region available to them. If an object does not fill all of its available space it leaves the possibility of other objects coexisting in the same space. For example, a person can simultaneously be both a scientist and a father. Counting the number of “father” behaviors during a day can give a fractal dimension.

3.5.2 Mandelbrot Set

The *Mandelbrot set* shown below is typical of this geometry. It is the mapping of the behavior of a complex mathematical formula which combines *real* numbers (integers, rational (fractions) or irrational numbers (π, or $\sqrt{2}$) with *imaginary* numbers (square root of negative numbers).

The seemingly infinite complexity of the set is based on the simple formula $Z\ Z^2 + C$. Take a number, multiply it by itself, and add the original number; then multiply the result by itself and add the result of the previous operation, and so on. This is the iteration process.

According to Briggs and Peat in their work *Turbulent Mirror: an Illustrated Guide to Chaos Theory and the Sciences of Wholeness* [79], an experiment performed by David Brooks in Prime Computer Co. showed that running a computer program generating the Mandelbrot set in order to a gradual increase of its size in 2,702,702,702 times (more than two thousand seven hundred million times), the figure showed self-similar structures again and again. In other words, the smaller substructure, represented inside a 5x5 cm square section of the screen was self-similar to the original figure inscribed in a square whose perimeter was equivalent to 1.3 times the distance to the moon. The calculations are repetitive; to produce the Mandelbrot set on a single screen takes an estimated 6,000,000 operations (iterations).

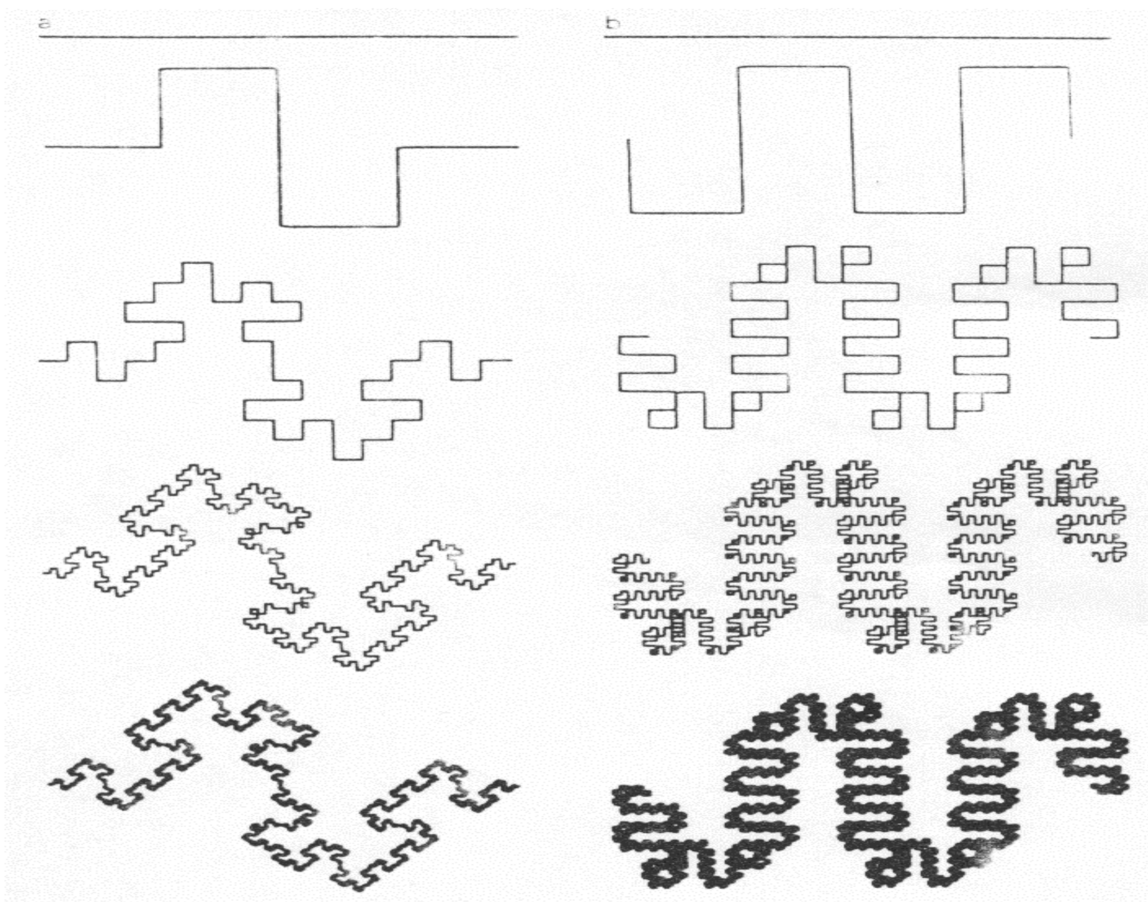


Fractal geometric figure known as Mandelbrot set

[79] J. Briggs and F.D. Peat, *op.cit.*

3.5.3 Koch Curve

The following figure shows in a) and b) (top to bottom) a series of curves that progressively show ramifications and refining, the so-called *Koch curves*. In each case, the one above is a wider and more sharpened section of the inferior curve, and the respective inferior curve is a ramification and refining of the one above. This is the property of symmetry, named self-similarity or self-similitude in the curves compared.
What happens when we refine and branch the curves but maintaining self-similarity? Following Mandelbrot's idea about the British coastline, if we described the dimension of an object of this type by defining the number of "little balls" needed to cover the object, it is possible to verify that the inferior curves of the figure require a bigger number of balls for "coverage" than the curves above. If we compare two sections whose length present a proportion of 1:2 in the superior curve, the surface of the respective sections of the inferior curves will be 1:2.88, i.e. $1:2^{1.5}$, where 1.5 is the value of the curve's dimension. The "curves" resemble a surface rather than a simple line.



Koch curves with fractal dimension D = 1.5 (a) and D = 1.79 (b)

The concept of fractal dimension and self-similarity is a mathematical one. For physical and chemical real objects, such as diffusion curves, surfaces of crystal or proteins, self-similarity will never be ideal along all longitudinal scales. There is a superior and an inferior limit. A surface can keep on breaking into self-similar fragments. It becomes increasingly fractured and the dimension gets higher and higher. We reach the maximum point as well as the limit, when we reach the molecular dimension. There is also a macroscopic limit. From the macroscopic point of view, a mirror has exactly dimension two. However, if we observe the surface under an electronic microscope, we may probably see a "mountain" of higher dimension.
As an example, the following table reproduces the values corresponding to some fractal objects in nature. The surface of proteins, for example, does not have a dimension of 2.0 (classic value) but 2.2. According to Friedrich Cramer, this could be extremely important for proteins' interaction calculations, enzyme mechanisms and all biopolymers life processes in function of a precise mathematical treatment. [80]

Object	**Fractal Dimension**
Coastline	1.2
Landscapes	2.2
Clouds surface –experimental as in theory of chaotic dynamics (turbulence)	2.35
Reticulated polymers, gels	2.5
Chain polymers in good solvents	1.676
Brownian movement in two or three dimensions; trajectory of the molecule in a liquid	2
Level of energy in molecule	<1
Protein skeleton	1.3 - 1.8
Protein surface	2.2 - 2.4
Solid surface	2 - 3

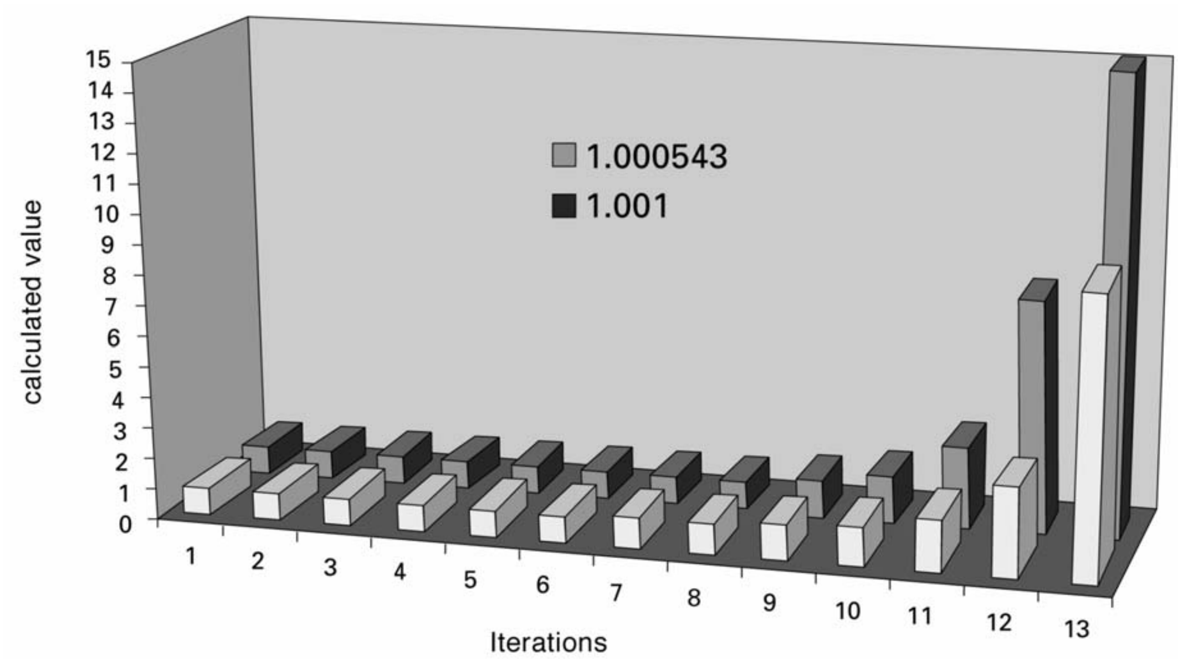
Again, there is a strong link between chaos and fractals. Fractal geometry describes the chaotic systems we find in nature. Fractals are a language, a way of describing nature. Euclidean geometry is a description of lines, circles, triangles, and so on. Fractal geometry is described in algorithms, a set of instructions on how to create a fractal, and thanks to computers we can translate these instructions into the wonderful patterns of fractal images.

3.6 Sensitive Dependence on Initial Conditions

When a person plants a flower garden, he or she may add fertilizer to enhance growth. In some cases, insignificant changes in the amount of fertilizer used may not make any difference on the later growth of the flowers. In this particular case small differences in initial conditions are of little consequence. In many cases, if fertilizer is not given to the plants, it will probably affect their growth. If too large quantities of fertilizer are given, this might kill the flowers. But tiny differences in the quantity of fertilizer, like small differences in the distance between the plants, may sometimes have no effect.

[80] Friedrich Cramer, *op. cit.*

Many of the systems men deal with as in the above example, act in a linear way. They can absorb small differences without it affecting their behavior. Giving them a slight nudge is not going to affect their course. Linear systems are, as a whole, generally insensitive to tiny differences in their initial conditions. Some of the systems humans deal with are of this kind: they are almost linear systems. Their output is proportional to their input. Tiny, insignificant differences in initial conditions or in measurements will not have major effects later. In other words, small differences or changes have small effects, and large differences and changes will have large effects, according to the above mentioned causality principle.



Sensitivity to inicial conditions: a succession repeated twice where each number is always multiplied by itself. The two cases only diverge in the initial number (1.000543 and 1.001).

People can plan things and live their lives with a measure of certainty when objects they deal with are insensitive to small differences in their initial conditions. Because of this insensitivity to small differences in initial conditions, many objects will generally develop in a linear way. They will change in the future as they did in the past. Little differences will generally cancel each other out. When changes take place, it is possible to know what outcomes will be. This is a case of dealing with orderly linear change; change that can be predicted.

Science built itself on this principle of insensitivity to small differences. James Gleick describes it thus: "*The basic idea of Western science is that you don't have to take into account the falling of a leaf in some planet in another galaxy when you are trying to account for the motion of a billiard ball on a pool table on earth. Very small influences can be neglected. There is a convergence in the way things work, and arbitrarily small influences do not blow up to have big effects*"[81].

[81] James Gleick, *Chaos, Making a New Science,* (New York, Penguin Books, 1987).

The belief in approximation and convergence was well justified. It worked. A tiny error in fixing the position of Halley's Comet in 1910 would only cause a tiny error in predicting its arrival in 1986, and the error would stay small for millions of years to come. Computers rely on the same assumptions in guiding spacecraft: approximately accurate *input* gives approximately accurate *output*.

"*In principle the future is determined by the past, but in practice small uncertainties are amplified, so that even though the behavior is predictable in the short term, it is unpredictable in the long term.*" [82].

However, as demonstrated by Lorenz (see **Butterfly Attractor**), there are phenomena in this world that do not change in linear way. When they change they are extremely sensitive to small initial differences, which in the process of repetitive change are blown up beyond all proportion.
People have known that chains of events can have far-reaching consequences like losing the nail on the horseshoe in the well-known saying[83]. But Lorenz had demonstrated that sensitive dependence on initial conditions, which is in effect, the enhancing of small differences that could not be measured accurately to enormous effects beyond prediction, develops naturally in many systems.
When they began looking, scientists found that there were many things that behaved this way. There are many systems in the world that are affected by small differences. In fact, the nonlinear world includes many of the changes in the living, the human, the social and the individual's world. There are many things that cannot be measured exactly, or if they can be measured, the slightest initial difference, if amplified repeatedly, may lead to unpredictable behavior. In very simple terms, all of this leads to a startling conclusion: in a nonlinear system, starting points that are almost the same may evolve into completely different ending points.

Two neighboring nations with almost identical beginning conditions can evolve into completely different national cultures. Two identical twins, with very similar beginning conditions can develop completely different personalities.
Two young brothers born and brought up in the same crime drug- and drug- infested slum, although influenced by almost similar starting conditions, may each go his own way. One may end up as a reputed scientist and the second may spend his days in prison. You may therefore expect that small inexactitudes or discrepancies in the measurement of a system in its initial state may be blown beyond all proportion at later stages of its development.
Howard Becker highlighted this in his *Labeling Theory*[84]. According to this theory, small differences in the processing and labeling within a criminal law system may produce big

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[82] J. Crutchfield, F. Doyne, N. Packard and R. Shaw, "Chaos", *Scientific American*, (Nº8, 1986), pages 46-57, cited by Uri Merry, *Coping With Uncertainty: Insights From the New Sciences of Chaos, Self-Organization and Complexity*. (Westport, Praeger Publishers. 1995), page 26.

[83] This proverb refers to the following story: "The messenger's horse lost its shoe; the rider died before reaching his destination because the shoeless horse tripped and fell; the message did not reach the king because the messenger died before seeing him; the king made a mistake in his battlefield strategy because he did not get the key information in the message and the war was lost, all because of a horseshoe".

[84] H. Becker, *Outsiders: Studies in Sociology of Deviance*. (New York, The Free Press, 1963), cited in Robin Robertson and Allan Combs (editors), *Chaos Theory in Psychology and the Life Sciences*, (op. cit.), page 228.

differences in the destiny of youths that are otherwise very similar in their demographic conditions. A group of children from Chicago or Dallas may end up in university, and another group in prison. The differences in the members of both groups may be so small that they would all take the same pathway (that of torus) but for the labeling process, i.e. how it is being "labeled" due to a "small" change in a crucial point of the moral career of the young boy. These labels are printed in the boy when the school authorities, the police, the court or other institutions send and publish those labels to peers, family members and neighbors[85]. Therefore, we can say that man lives in a world where , under certain conditions, the most trivial causes can have huge effects. This is called the butterfly effect.

The butterfly effect is in sharp contrast to the behavior of linear systems. According to Goldstein (1991): "*Sensitivity to initial conditions demonstrates that one would need infinite precision of initial conditions to predict the future state of a nonlinear dynamical system since errors in the measurement of the initial conditions, no matter how seemingly small and insignificant, would soon be amplified from their microscopic effect to a macroscopic influence on the system's evolution ... The key to the amplification of the uncertainties or fluctuations in initial conditions hinges on the non-linearity showing up in Lorenz' equations. Non-linearity introduces the possibility of exponential relationships between variables in a system, so that a small change in one variable may result in a large change in another variable.*"[86]

As seen before, attractors define and prescribe different basic modes of behavior in systems. It is possible to group together the point and limit cycle attractors as they both depict fixed linear modes of behavior and change. Strange attractors, in turn, describe systems from linearity and predictability through stages of an intermix of linearity and non-linearity, to an increase in unpredictability, and into total deep chaos where complete

[85] According to Anthony Giddens the investigation in the Labeling Theory interprets the deviation towards crime not as a series of individual or group characteristics, but as an interaction process between the deviated and non-deviated individuals. From this perspective, the idea is to get to know why some are labeled as "deviated" in order to understand the nature of the deviation. The law and law enforcement representatives or those who can impose conventional morality definitions upon others, which is the same, constitute the main labeling source. Therefore, the labels used to create deviation categories are an expression of the power structure in society. In general, the rules defining deviation and the context of application are designed by the rich for the poor, by men for women, by seniors for youths, and by ethnic majorities for the minorities. For example, many high-class neighborhood children may perform actions such as jumping around in other people's yards, breaking windows, stealing fruit or playing truant, the teachers or the police may consider it as an innocent aspect of the growth process. On the contrary, in poor areas, this kind of behavior may be considered as the evidence of a tendency towards teenage crime. Once the kid has been labeled as a criminal, he or she is stigmatized as such and he or she will probably be considered (and treated as) not trustworthy by the teachers and future bosses. The individual will then repeat criminal behaviors, thus broadening the distance from orthodox social conventions. The Labeling Theory, although object of debate, is important because it is based on the assumption that no act is intrinsically criminal. The criminality definitions are instituted by those in power through the passing of laws and their interpretation by the police, the courts and other law enforcement agents and institutions.
Anthony Giddens, *Sociology*. (Spanish edition: Madrid, Alianza Universidad Textos. 1995, 6th Edition), page 163.

[86] Jeffrey Goldstein, "Causality and Emergence in Chaos and Complexity Theories", in W. Sulis & A. Combs (editors), *Studies of Non-linear Phenomena in Life Sciences (vol 5): Non-linear Dynamics in Human Behavior*, (London, World Scientific Publishing Co. Ltd., 1996), pages 161-190.

randomness reigns. This modes of behavior may also be regarded as different ways of a human or social system -an individual, and organization, or a nation- can behave.
Some scientists, like Prigogine prefer dividing behaviors into equilibrium, close to equilibrium, far from equilibrium, and deep chaos. T.R. Young, from the Santa Fe Institute for the Study of Complex Systems, divides behaviors into four kinds:

a) linear behavior (point and cycle), where there is little space for human agency
b) torus-like behavior, with one outcome basin, having a limited room for human agency.
c) Butterfly-like behaviors, swayed by strange attractors with two up to sixteen outcome basins.
d) Deep chaos, beyond sixteen outcome basins, where freedom overwhelms human agency and entirely new forms of order emerge[87].

Young describes these forms of behaviors in the following way:

A. Repeating former behavior in the same way
B. Varying behavior slightly and predictably
C. Adapting new behaviors (butterfly-like)
D. Chaotic behavior leading to

(E), a new more complex mode.

According to Young, a human system probably never does something in exactly the same point or cyclic way (A). Sometimes in industrial repetitive tasks attempts are made to attain this kind of behavior. Some individual and social behavior can be described as varying behavior slightly and predictably (B), for example shaving[88]. New behaviors intermixing linearity and non-linearity (C) may also be adapted, as when migrating to a new country. Individual and social behavior can sometimes go through phases of almost total chaos (D). There may be circumstances where each of these different kinds of behavior are appropriate. There are times when behaving in one of these modes and not the other would be problematic. Behaving predictably but slightly differently each time or adapting new behaviors with different degrees of linearity and non-linearity, or functioning chaotically are as much as a natural and necessary form of behavior as the other forms[89] .
Scientists at the Santa Fe Institute of Complexity have found that complex adaptive systems (e.g. individuals, families, organizations and nations) are able to survive and adapt more effectively in turbulent environments, when they are functioning in a mode that is described as “the edge of chaos”. This probably describes behavior somewhere within the nonlinear, far from equilibrium category C (the butterfly intermix of predictability and unpredictability).

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[87] Uri Merry, *Coping With Uncertainty: Insights From the New Sciences of Chaos, Self-Organization and Complexity*. (Westport, Praeger Publishers. 1995), page 37.
See also: T.R. Young, *Chaos and Causality in Complex Social Dynamics*. (Michigan, The Red Feather Institute, 1994).

[88] In A.D. 161, Roman Emperor Marcus Aurelius described his surrounding everyday world by saying: “look and you shall see the same thing over and over: people get married, raise children, get sick, go to war, die, go to parties, engage in trade, cultivate the land, profess adulation, behave arrogantly, become suspicious, participate in conspiracies (…), lust for high positions and power”. He said this more than 1800 years ago in his *Meditations.*
Juan Gallo, “Las Cápsulas del Tiempo”, in the Argentine newspaper *Clarín,* July 5th 1999, section: Zona, page 13.

[89] T.R. Young, *op. cit.*

3.6.1 Second Order Change

Under specific conditions, a small change in a key parameter can force a stable torus to break up into two or more tori: Lorenz' butterfly-like attractor. It is very important to remember that it is a small change *in the same variable* that offers qualitatively different fates in either of the two wings.
The butterfly effect arouses many doubts as to how much it is possible to invest in ten-year national plans, or to engage in a corporate strategic planning, or to rely on the "planned change" in families, organizations, and other social systems, or otherwise being tied to long term standards.
On a worldwide scale, the realization that small causes *can* have enormous effects may be seen from two points. A pessimistic view would indicate that a slight error in the judgement of a national leader or a miscalculation in the building of a nuclear plant would lead to a nuclear catastrophe. On the other hand, an optimistic look of the butterfly effect would note the openness of evolution to human actions. This allows for a small group of enlightened individuals – as in the case of environment protection organizations- to spread their views, thus affecting exponentially, the outlook of the people throughout the world and ushering in a more humane, caring and responsible era in human history.

Small reductions in income (or increases in expenses) can trigger qualitative change among white-collar professionals in tactics to generate income. In a given society, at one point in time, most if not all physicians might behave pretty much the same toward their patients in terms of diagnoses and prescriptions for tests, medications and surgery. Given small changes in certain parameters of income and/or living expense, some number of physicians might begin to over-prescribe for patients and over-bill third party carriers. Of the universe of doctors, each with very similar socialization, personalities, and lifestyles, a small change at a change point might send one into embezzlement, stock fraud, medical care fraud, or income tax evasion, while the other might make adjustments in lifestyle (moving to a smaller house, selling a second home or third car, borrowing from family or friends). The operative point upon which to focus is that it would be impossible to predict which of that universe of doctors would engage in deviant behavior. All that the deviancy theorist could be certain of is that, given small changes in key parameters, even larger number of doctors will defraud or mistreat their patients.
Both behaviors result from the same butterfly attractor as comprised by two tori; each of which is a qualitative different outcome basin for very similar systems. This is the essence of second-order change; similar patterns will have different fates depending upon their journeys through uncertainty. Under some social conditions, an outcome basin in which each set of persons has a different fate could be, in human terms, desirable. In mapping the socialization of children, there comes a time when most scientists track one set of children into one set of status roles and another set(s) into other status roles. Gender differentiation, occupational differentiation, ethnic and religious differentiation are examples of normative bifurcations in outcome states between persons with but small differences in initial states. Such differentiations serve as reservoirs of variety from which nonlinear transformations to new states are possible, thus, increasing survival chances in an ever-changing and sometimes hostile macro-environment. Differentiations may be helpful also in that specialization occurs and experience is augmented. Yet the continuing subdivision of labor may be inimical to both quantity and quality of work. Stratification, as mentioned, also may have limits beyond which there is so much uncertainty accumulation

for those at both the top and bottom that the pattern and predictability so essential to social processes fail.

3.6.1.1 Far-from-Equilibrium States and Self-organization

It is worth clarifying that the terms equilibrium and far-from-equilibrium have caused a certain level of confusion. These terms are key terms in the Prigogine Brussels school, which has been, to some degree, at odds with the American chaos school. In Gleick's (1987) popular account of chaos, he did not even mention Prigogine; and Briggs and Peats (1989) separated their book into two sections: "Order to Chaos" for chaos theory per se, and "Chaos to Order" for Prigogine and self-organization[90].

Originally, in ancient Greece "equilibrium" referred to a linear *balance* of weighs on a lever such as Archimedes studied. This balance of weights went on to play a role as a determinant condition for scientific research and theorizing. Eventually, with Boltzmann's formulation of the Second Law of Thermodynamics in the 19th century, the concept of "equilibrium" had made a full semantic passage from a simple determinant conditional to the final, sought-for state of a system [91].

In psychology, equilibrium also found a linguistic home. Equilibrium-based conceptions played a key role in the psychology of Herbart, Lotke, Freud, Lewin, and Parsons.

Prigogine[92] popularized the term "far-from equilibrium" when he referred to the conditions necessary for a system to bifurcate and self-organize. He was using this term against the backdrop of thermodynamics, which was suffused with equilibrium-based concepts. In Prigogine's search, far-from-equilibrium conditions led to systemic behavior different from what was expected by the customary interpretation of the Second Law of Thermodynamics, the emergence of new structures and ordered configurations.

Another area of confoundedness with the terms "equilibrium" and "far-from-equilibrium" is that they are often used interchangeably for "stability" and "instability". The latter terms have specific meanings in dynamical theories – stability being defined as a system returning to the same dynamics after a small perturbation, whereas instability referring to a change in the qualitative dynamics of a system after a perturbation. That is why, for example, a pendulum can be in either stable or unstable equilibrium. But that means that the two sets of terms cannot be purely synonymous [93].

On the other hand, in popular parlance, equilibrium connotes balance, rest, integrity, safety, and so on, whereas disequilibrium (the closest popular term to *far from equilibrium*) is associated with being off balance, dizziness, stumbling, vertigo, and so on.

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[90] James Gleick, *Chaos, Making a New Science*, (New York, Penguin Books, 1987).
J. Briggs and F.D. Peat, *Turbulent Mirror: an Illustrated Guide to Chaos Theory and the Sciences of Wholeness*, (New York, Harper and Row, 1989).

[91] Jeffrey Goldstein, "Causality and Emergence in Chaos and Complexity Theories", in W. Sulis & A. Combs (editors), *op. cit.*, page 44

[92] Ilyia Prigogine e Isabelle Stengers, *op. cit.*

[93] Jeffrey Goldstein, "Causality and Emergence in Chaos and Complexity Theories", in W. Sulis & A. Combs (editors), *op. cit.*, page 45

The physical sciences generally tended to concentrate on systems that were in equilibrium or close to equilibrium. These systems behaved in a predictable, linear fashion that the sciences knew how to deal with. They always returned to their same predictable selves. Touch a clock's pendulum and after some time it will return to its original oscillation. Far-from-equilibrium systems do not return to their regular state, they never repeat themselves and they are nonlinear. They were unpredictable systems and for many years the physical sciences did not understand them and chose not to deal with them.
The basic outlook of science, as dealing *only* with near-to equilibrium systems, was changed by the work of Ilya Prigogine. He demonstrated how many kinds of open systems, such as chemical, biological, and social systems, operated at far-from-equilibrium states.
A far-from-equilibrium system does not return to some fixed stable state. It is forever a continuous flux of change: never being the same, always becoming something else. A far-from-equilibrium system is never being the same, it is always becoming. Prigogine spoke about his theory as "from being to becoming"[94]. A far-from-equilibrium system is like the flame of a candle or a whirlpool in a river. Its wholeness, structure, and form can only be maintained by the endless flow through it. Its existence depends on its flux. In the face of the relentless change, the system is using a lot of energy to maintain itself as being whole and coherent. The constant flow of energy through it enables it occasionally to take a quantum leap in which it transforms itself and reorganizes itself into a new basic order.
Systems such as these do not always dampen changes and fluctuations but sometimes amplify them so that the fluctuations invade and agitate the system. At a certain point the fluctuations pass a critical threshold and then, following a transitional stage of chaotic fluctuations, completely reorganize the entire system. In fact, the nonlinear interactions in far-from-equilibrium open systems allow the system to pass from one basic state to another in discontinuous transitions. As the transitions are discontinuous, the forms they will take, like that of the star-shaped crack in a window, cannot be foretold.

From the mechanical point of view, Prigogine explained in detail the self-organization operation in heat transfer systems and chemicals, and for the first time connected self-organization to living systems. His systems were not living systems, but they behaved as if they were. Due to his influence, works such as General Systems' Theory by Von Bertalanffy[95] were linked to more formal thermodynamics and simple-based systems.

Spontaneous self-organization is a phenomenon that emerges in far-from-equilibrium systems. Often called *dissipative structures*, these systems are capable of keeping their identity thanks to their capacity to stay open to exchange with their environment. Culture is a typical example of an open system and can be viewed as an organic or live, complex system exhibiting the typical features of chaotic behavior: non-linearity, complexity of shape, recursive symmetries between different levels in the fractal scale, sensitivity to initial conditions and feedback mechanisms.

In *Introduction: The Nature of Living Systems*, James Miller[96] describes all living being as complex structures and open systems. In his work, Miller identifies eight levels of

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[94] Ilya Prigogine, *From Being to Becoming*, (San Francisco, W. H. Freeman, 1980)

[95] Ludwig von Bertalanffy, *General Theory of Systems,* (Spanish edition: México D.F., Fondo de Cultura Económica, 1995).

[96] James Grier Miller and Jessie L. Miller, *Introduction: the Nature of Living Systems*. In Behavioral Science (Nº35, 1990). Pages 157 –163

increasing complexity in living beings: cells, organs, organisms, groups, organizations, communities, societies and supranational systems. If we consider social systems according to this classification, the physical and cultural interaction becomes an essential element to understand complex phenomena. No system can exist in total isolation. On the contrary, each living system keeps permeable links that enable it to import the energy necessary for it maintenance. “Energy in living systems takes the form of matter or information. Information energizes the social system, allowing it to survive, while at the same time, it enables exchange with other systems. The information “input” gives the system the possibility to develop essential activities, such as structure production, reproduction and maintenance. It also makes time-space orientation possible, as well as reaction and adjustment to changing circumstances in order to find food and receive feedback in connection with the system’s own actions”. [97]

In connection with the function of these permeable links in open systems, Fischer says that “the family constitutes a typical open system where members frequently enter and leave the system (e.g.: someone going to the office or school). Information also enters the system every time someone turns on the TV or the radio, reads the newspaper, uses or answers the phone”[98].

As we said, living systems are characterized by their openness, their non-linearity and their interdependence. A culture, a community or a group is a living system with information links transmitted around its members. This information process, apart from transmitting data, keeps and consolidates social connections.

Again: self-organization and self-maintenance dynamical organizations occur spontaneously far-from-equilibrium (not in or near equilibrium). The energy flow plays a key role in the creation of such order conditions in the real world. The key in situations of unbalance is far-from-equilibrium.

Self-organization in non-living systems provides us both with a metaphor and a conceptual model for living and supra-living systems (e.g.: cities). Even in physical, simple, self-organized systems, such as whirlpools and tornadoes, there are limits, i.e. ordering activities that maintain the shape of the system (its identity), and the exchange of energy with the environment to keep the distance from equilibrium. Prigogine has described how self-generated, self-maintained and self-organized dynamics produce and maintain this phenomenon spontaneously.

On the other hand, new ways of organization emerge through the process of order by fluctuation. Self-organization is generally the result of a “*small fluctuation that expands into a new shape*”. A simple experiment, called *Bernard cell*, gives an example of its meaning. Bernard cell is a box filled with a fluid to which heat is added. Under low temperatures, heat disperses due to the random molecule collision. Although the fluid is in oscillating motion, it looks homogeneous; there is no coordinated movement. Small groups of warm and cold molecules have united and they move separately everywhere; at higher temperatures, something interesting occurs: some groups of warm molecules move upwards as a whole because their heat content makes them lighter, and thus more

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[97] James Grier Miller and Jessie L. Miller, *op. cit. page* 160.

[98] Aubrey B. Fisher, *Perspectives on Human Communication.* (New York, McMillan Publishing, 1978). page 200

vigorous than the others. This type of event starts to take place everywhere. Finally, one group ascends to the top, pushes the other molecules upwards while losing heat in colder regions, and descends again. Suddenly, the complete region starts a coherent and coordinated circular movement, a self-organized movement.

Prigogine showed that this type of process of order through fluctuation occurs in all type of systems, i.e. heat, chemical and living systems. In human relations, this is metaphorically observed in popular uproars. A small group with a different configuration drills the energy compound, becomes a conductor and produces a different flow. A new configuration emerges from the previous one.

Life means self-organization, self-creation and innovation emergence. It needs far-from-equilibrium conditions. Life is built on the basis of far-from-equilibrium change. Growth and individual development are on a far-from-equilibrium base. Social systems -nations, institutions, organizations, work teams, family units- created by human to organize their lives, constantly need to cooperate and coordinate their actions and change these actions in view of changing circumstances. These systems and their components must adjust their behavior to that of the environment. The only way for social systems to continue existing under these circumstances is through far-from-equilibrium structured behavior because far-from-equilibrium in interdependent nonlinear systems -human and social systems- implies a source of chaos and renewal.

According to the *General Evolutionary Theory*, for self-organization tendencies to come into being, persist, and move to higher and higher levels of organization, there must be: a) a reason, and b) a sense of how this process works as a whole (not only in specific places). The emerging answer is that the growth of complexity (evolution) is an energy-flow phenomenon.

According to Goerner[99], several factors support this answer.

First, self-organized systems always increase the rate of energy transfer. The more intricate the organization, the faster the energy flows. Second, self-organized systems are also known to go through a series of organizations and reorganizations as part of accelerating energy flow. Channeled energy flow phenomena go in a direction and lead to increasingly complex and intricate patterns. We need only think of boiling water: as heat increases, you get little bubbles, then strings of bubbles up the side, ripples, undulations, and finally a full, rolling boil. Each stage sets the stage for the next and each transfers energy a little faster.

This same acceleration of energy flow has been observed over the evolution of life on earth, the succession of ecosystems (grass plains to oak forests) and the evolution of the universe (atoms to galaxies). There is a great deal of evidence that evolution of increasingly intricate ordered forms is an energy-flow-rate phenomenon. In other words, increasing levels of *ordered complexity* are intricately tied to increasing rate of energy flow. Order and energy-flow efficiency go hand in hand.

3.7.2 Perturbation and Transition: The Edge of Chaos

[99] Sally Goerner, "Chaos, Evolution and Deep Ecology" , in W. Sulis & A. Combs (editors), *Studies of Non-linear Phenomena in Life Sciences (vol 5): Non-linear Dynamics in Human Behavior*, (London, World Scientific Publishing Co. Ltd., 1996), pages 17-38.

Many of the familiar things in the world are static, like a rock, i.e. they do not seem to change. Others change so rapidly that we fail to recognize the change. For example, air molecules are constantly moving and we just detect the statistical average of its properties, such as pressure. Everything changes continuously at a certain speed. We erroneously conceive things as static due to their time or size scale in relation with our limited perception capabilities.
It is in the intermediate scales where we can distinguish the movement of the parts while not overlooking the whole; the most interesting characteristics of complex systems are found in these scales.
Let us imagine domino pieces; each of them is at a distance of half its size from the preceding and following piece. Now, we flick the first one in the direction of the row and... what happens? It falls and pushes the second piece which in turn makes the third one fall and so on until all the pieces are in a horizontal position.

The slight stroke that made the first chip fall is called *perturbation*, the time when something occurs is called *transition*, and the final situation, *stable condition*. As the example described above does not seem to be interesting enough, let us imagine that instead of a row, the pieces are in circle and that each of them has a spring that slowly makes them go back to the upright position after falling. Consequently, the first piece will go back to its initial state, verticality, at the same time as the last one falls, and so on.
It is obvious that some energy may be lost, and eventually the movement of one of the pieces will not be enough to make the next one fall; therefore, perturbation would be at zero level. The final state and the initial state will be equal, i.e. all the pieces will be in an upright position. The intensity of perturbation can be measured in terms of the effect produced -i.e. *the duration* of perturbation (or time length of transition)- plus the resulting *permanent change* (not applicable to the example described above).
This is so for any system and it is a measure of its stability. Short transition periods and the return to the initial state are necessary if, analyzing building constructions during an earthquake, collapse is to be avoided; a "jelly" effect would occur if the opposite were inevitable.
Consider the example of air molecules. They constantly collide; they neither stand still nor return to the same state: they are chaotic. In this situation, the transition period is infinite, while for the best method of construction, it will be zero.
We are thus confronted to two situations: one with period zero (static system) and one with infinite period (chaotic system). But what happens in between? Let us imagine a room full of people. The situation is unstable. What happens in there is dependent on a number of reasons. If a person shoots a gun, there will be panic, chaos. If nobody moves, the situation will be static. On the other hand, conversations will start and end at some time, people will leave the room, and somebody may go in. In summary, there are activities that start and end. Each of these options is accompanied by a transition. A phrase is likely to be overlooked (zero transition), initiate a string of answers that either die and the people in the room forget about (short transition) or it may be so interesting for the participants that they may repeat it to their friends, who in turn will repeat it to other people and so on, as in the case of Karl Marx' *Communist Manifesto* that has been echoing around for 150 years).

This instability with order is called *the edge of chaos.* Lucas describes it as a "*system half way between the domains of stability and chaos*"[100]. Its main feature is the potential to

[100] Chris Lucas, *Complexity and Artificial Life: What are they?* (and other papers) (Manchester UK, CALResCO, http://www.calresco.force9.co.uk/cal.htm, 1996)

develop structures of very different scales (the three above-mentioned transition periods may occur simultaneously to the extent they affect several different individuals in the group). This is often a basic characteristic of complex systems whose parts have a certain degree of freedom to move independently.[101]

The idea of transition is applicable to inorganic natural systems and organic ones; this is meaningful because most of the sciences are based on one type of system, and the conclusions are applicable to particles (physics), metabolism (biology), the mind (psychology) or society (social sciences). The concept of transition provides a quantifiable parameter that may be applied to all of these systems. This is the essence of this approach to complex systems: ideas that can have universal application.

For behavior at the edge of chaos, the parts of the system should be neither fixed nor free. In other words, certain restrictions are necessary because on the one hand, if there are too many parts, their dynamics will extinguish; on the other, very few with their implicit order will not keep up. To make this graphic we could find numerous analogies, from phase systems in the world of physics (solids, liquids, and gases) to political systems (dictatorship, democracy, and anarchy).

The edge of chaos is both a simple and difficult concept. We know that something interesting will actually occur; we do not understand *what* will occur. Understanding the patterns emerging form the specific ways of interaction is the great challenge that derives from complexity theory. We can analyze how the transition period criterion relates with behavior; this provides a valuable indicator and a unit of measurement to predict both human behavior and the interaction of the artifacts we create.

The traditional science usually concentrates on the stable condition of systems' behavior: the equilibrium position. Initial conditions are assumed as irrelevant, since equilibrium is independent from the starting point –all final positions end up with the same behavior (e.g. the sediments in a chemical reaction always keep the same balance of its constituents; a planetary orbit follows the same pattern regardless of its initial position). In these studies, transitions are discarded and the system is given the time to settle. In many cases, the system is isolated from external interferences (physical or conceptual), thus preventing any type of disturbance.

For complexity and chaos theories, transition is the current behavior and therefore, the stable condition is irrelevant from this perspective. Complex systems of the type analyzed here never settle into a stable system. They are subjected to constant perturbations that lead them to transitional behavior. And this is what researchers try to understand.

Take a society; it is said to be in stable state only when all the people are sleeping. New ideas frequently disturb the population, they nurture the minds and there is mutual influence, new behaviors, namely transitions, are generated. Perturbations and transitions are closely linked in infinite feedback loops.

The patterns of this behavior are sought after, i.e. properties held invariable in different starting points. In general, a complex system can have many dynamical modes of operation (think of a crowd of soccer fans, and all they can do in the stadium). These modes relate in a combination of regular changes and surprising changes. For example, a chant suddenly starts and continues until the perturbation (a goal scored) modifies the state (to happiness). The crowd remains in its place until there is a new perturbation (the

[101] On systems at the edge of chaos, see Uri Merry, *Coping With Uncertainty: Insights From the New Sciences of Chaos, Self-Organization and Complexity*. (Westport, Praeger Publishers. 1995)

referee signaling the end of the match) and the "fan" system conditions are modified (some run to the field close to their team and others run to the exit).
These properties are not restricted to social systems. Any system under tension can experiment rapid changes of state. One of the most frequent ones is related to earthquakes. It has been discovered that seismic activity results from a law of force distribution. The severity of the quake is related to its frequency through an inversely exponential formula. There are several minor quakes in every period before a big one. This escalating relation is widely applied and shows an important characteristic of the systems analyzed here. It cannot be generally stated that a greater perturbation will have a greater effect, and that a minor perturbation will have a minor effect. What is peculiar is that the effect of any system's perturbation can range from zero to infinite, and there is inherent unpredictability. This is an instance of damage to the strong causality principle.

At this point it is worth analyzing the concept of *correlative distances.* Correlation measures the level of "brotherhood" of a state and its neighbor and can range from 1 (identical state) to –1 (opposite state). A high correlation in adjacent areas is expected from a solid since its atoms are in the same molecular arrangement. If we relocate (transform) a portion of the solid, we can do exactly the same with its adjacent neighbor. It does not matter how far we place it. It will always fit because of its constant correlation as to the distance.
But what happens with gases? Correlation should be zero since there is no order in gas. Each molecule behaves independently. Again: the distance is not significant since it is zero in all scales.

Anyway, from the statistical point of view, notice that each portion of gas or solid is identical to its neighbor. For this reason, in chaos situations, an alternative definition of *transition duration* is frequently used: *the duration or length of transition is the number of cycles before the statistical return of convergence (*when it cannot be stated that something unusual has occurred and the system has returned to the stable condition of equilibrium). As for instantaneous chaos we may say that its transition length is zero and that its condition is static, since no change can be detected. This definition will be used from now on.

Thus, complex systems show neither a maximum of correlation (nothing happens) nor zero correlation (too much occurs) but correlations that vary in time and average somewhere around the middle.
What we will actually find are strong short-range correlations (local order) and long-range weak correlations (think of individuals who behave similarly to their neighbors but whose behavior does not "fit" with the rest in distant countries).

According to the new definition above, this corresponds to long transition duration and it provides two complexity measurements (a distance-dependent correlation, and long non-statistic transition); these two metrics are mathematical indicators of *the edge of chaos.*
Liquids are good examples of this type of state since they are between solids and gases. They have free associations in their molecules – short-range order, but not a strong general structure, i.e. a long-range disorder. This type of organization permits local constructive blocks to be associated in a free framework, similar to logical computer designs.
It is worth considering what happens when we heat and freeze systems. At high temperatures, systems are in gaseous conditions, i.e. chaotic state. At low temperatures, we find solid systems, of static behavior. At a certain point, in the middle, the system's

state changes (state transition). Complex behavior emerges from the liquid state (e.g. the strange behavior of water in liquid state). We can thus control complexity through external forces (heating or disturbing the system more strongly lead to an increase in the chaotic behavior; cooling or isolating the system helps fix it in the state reached by then). This is clearly seen in the body temperature (low = hypothermia, static; medium = organized behavior, average; high = fever, chaotic).

3.8 From Third-Order Change to Deep Chaos

As we have seen before, after the third bifurcation, given the system's condition, another small change in the system can produce a wide range of final states where the system (a person, group, company or society) can tend to go.

However, behavioral and social sciences are built on a model that regards all human systems as equilibrium seeking. Human systems have certain levels of functioning that they try to maintain. When this equilibrium is disturbed by the effects of some change, the system will after some time return to functioning at its equilibrium state. This is called *homeostasis*.

From this viewpoint, when something happens to a family, or an organization to change its regular relationships, the system will do everything possible to eliminate the disturbance and return to its regular way of behaving and relating. Resistance to change is regarded as the system seeking to maintain its equilibrium and return to homeostasis. Equilibrium is the balance of forces pushing for change and of forces trying to maintain the system's cohesion and inertia. The stability and regularity of the functioning of social systems is ensured by their seeking to return to equilibrium and maintaining homeostasis. People often ignore the fact that the constants they find, such as homeostatic mechanisms, are features of their own creation and need for order.

However, this generalized vision of regarding the social system as a regular, constant, and predictable system is from a linear perspective. Nations, societies, institutions, families, and individuals do not behave in this way; their behavior is not regular, orderly and cannot be predicted. The approach that regards social change as a gradual transition from one state of equilibrium to another where order, regularity, and predictability are maintained in the system by its tendency to continue functioning in the same way as before (near its equilibrium), ignores the states of disequilibrium in the human world. The human world, like the non-human world, is not only of linear order and continuity, but also of non-linearity and discontinuity. In this sense, chaotic reactions are possible in social systems due to the annulment of strong causality (i.e. similar causes have similar effects) because social systems' groups or institutions are open systems with irreversible processes, intertwined causal chains, and multiple feedback loops, where linear order and chaos intermix in different degrees and they alternate throughout the system's life. A period of relative order is followed by a period of chaos, which in turn brings forth a new order. This period of deep chaos is a natural and necessary part of the development of all living and social systems. The conditions that are the fertile ground for the creation of a new order are born out of the turbulence of chaos.

Complex systems at some time in their history reach a point where they have to go through a total restructuring to continue functioning. At this bifurcation junction they go through a chaotic transition to enable themselves to give birth and self-organize in a new form. To understand how this happens, it is necessary to analyze the science of Self-organization.

3.8.1 Feigenbaum's Constants

In 1975, Mitchell Feigenbaum[102] of the *Los Alamos National Laboratory* made a breakthrough that proved universality existed in the transition points of different kinds of systems on their way from linear order to deep chaos states. While working on completely different systems, the same number came out. Feigenbaum had discovered constants that did not depend on the systems and were universal in entirely different systems. These universal numbers, which are ratios, are now named after their discoverer: they are the *Feigenbaum numbers*. After the fourth bifurcation, when the key parameters reach about 3.7 (called the Feigenbaum Point) all systems cascade into total deep chaos, where infinite choices create a situation in which freedom has no more meaning.
The Feigenbaum numbers showed that systems of a completely different nature would behave in a similar manner when turning chaotic. They allowed scientists from a variety of disciplines to predict the onset of turbulence in the real world systems they were studying. The Feigenbaum numbers were applied and found to predict the transition points on the route to chaos in phenomena as wide apart as optical systems and business cycles, electrical circuits and population growth, or the flow of gases and human learning. *Newsweek* reported in its May 25, 1992 issue that Michael Sheridan of the State University of New York used the model to predict avalanches on Colima volcano in Mexico.

Social and behavioral scientists have begun working on the implications of these findings for forecasting basic transitions in human systems. It is probably a matter of time before the Feigenbaum numbers will be used to warn of oncoming chaotic states in human and social systems. Well-managed companies may not survive a great depression, while other badly managed businesses may not collapse[103]. A slight difference in the location, in customers' relations, in marginal profit, may lead a well-managed company to bankruptcy. The nonlinear feedback of failures may trigger the bankruptcy of other renowned companies or maybe contribute to the survival of badly run companies. In the limits of the stable regions of such outcome basin, the destination of any specific business is quite unpredictable.

The world is full of objects that cannot be measured with precision and the universe is full of discontinuous facts, such as explosions, material cracking, eruptions or transformations. However, as people see regularity and order everywhere, they tend to ignore real world's phenomena that do not change linearly and orderly but chaotically. The behavior of a person, a group, and organization or a nations always affects other systems of their type, and it is affected by the reaction in a long chain of repeated and mutually affected relations. The same occurs with the relations of an individual's subsystems, i.e. body and mind.
When human systems -interdependent with other human systems- hold nonlinear interactions, and these interactions are repeated and combined with sensitivity to small

[102] J. Briggs and F.D. Peat, *Turbulent Mirror: an Illustrated Guide to Chaos Theory and the Sciences of Wholeness*, (New York, Harper and Row, 1989). page 64.

[103] T.R. Young, "Chaos Theory and Social Dynamics: Foundations of Post-modern Social Science" in Robin Robertson and Alan Combs (editors), *op. cit.*, page 231.

differences, the conditions for varying degrees of chaotic episodes are created. However, systems sensitive to initial conditions do not always exhibit a chaotic change. The change becomes chaotic only when given iterative amplification, initial errors, differences and inaccuracies explode. Randomness and unpredictability are only appear when these initial differences are magnified.

3.9 Chaos Theory and Forecasting

In ancient times, the ability to predict the future seemed to be a mysterious power of prophets, priests and astrologists. In the oracle of Delphi, for example, the seer Pythis (6^{th} century BC) revealed the destiny of kings and heroes in a state of trance. In modern times people came to believe in the unbounded capabilities of Laplace's demon: Forecasting in a linear and conservative world without friction and irreversibility would be perfect. We would only need to know the exact conditions and equations of motion of a process in order to predict the future events by solving the equations for future times. Philosophers of science have tried to analyze the logical conditions of forecasting in the natural and social sciences. Belief in man's forecasting power has been shaken over the course of this century by several scientific developments. Quantum theory teaches us that, in general, we can only make predictions in terms of probabilities. A wide class of phenomena is governed by deterministic chaos: although their motions obey the laws of Newtonian physics, their trajectories depend sensitively on their initial conditions and thereby exclude predictions in the long run. A random event such as the stroke of a butterfly's wing, can, in principle, according to Lorenz' statement influence the global dynamics of weather. Patterns and relationships in economics, business, and society sometimes change dramatically. Going beyond the natural sciences, people's actions, which are observed in the social sciences, can and do influence future events. A forecast can, therefore, become a self-fulfilling or self-defeating prophecy that itself changes established patterns or relationships of the past.
But nearly all our decisions are related to future events and require forecasts of circumstances surrounding that future environment. This is true for personal decisions, such as when and whom to marry or when and how to invest savings, and for complex decisions affecting an entire organization, firm, society, or the global state of the earth. In recent years increased emphasis has been placed on improving forecasting and decision making in economy and ecology, management and politics. Economic shocks, ecological catastrophes, political disasters, but also chances such as new markets, new technological trends, and new social structures, should no longer be random and fateful events sent by the gods. People want to be prepared and have thus developed a variety of quantitative forecasting methods for different situations. From a methodological point of view, every quantitative forecasting instrument can be characterized by a particular predictability horizon, which limits its reliable application.

The most common quantitative forecasting methods are the time-series procedures. They assume that some pattern in data series is recurring over time and can be extrapolated to future periods. Thus, a time-series procedure may be appropriate for forecasting environmental factors such as the level of employment or the pattern of weekly supermarket sales where individual decisions have little impact. But time-series methods cannot explain the causes behind the data patterns.
In historical times, the method was used by the Babylonian astronomers who extrapolated the data pattern of moonrise into the future, without any explanation based on models of

planetary motion. In the 18th century physicists knew little about the causes of sunspots. But in the observations of sunspots a pattern of frequency and magnitude was found and predictions were possible by its continuation through time-series analysis. In business and economics, there are various underlying patterns in data series. For example, a seasonal pattern exits when a series fluctuates according to some seasonal factor as products whose sale depends on weather. A cyclic pattern may not repeat itself at constant intervals of time, e.g., the price of metals or the gross national product. A trend pattern exists when there is a general increase or decrease in the value of the variable over time. There may be sub-patterns of trend, cycle, and seasonal factors, which must be separated and decomposed in analyzing the overall pattern of the data series.

In general, the computer-based automation of forecasting followed along the lines of linear thinking. On the other hand, the increasing capability of modern computers encouraged researchers to analyze nonlinear problems. In the mid-1950's, meteorologists preferred statistical methods of forecasting based on the concept of linear regression. The development was supported by Norbert Wiener's successful predicting of stationary random processes. As we have seen, Edward Lorenz was skeptical about the idea of statistical forecasting and decided to test its validity experimentally against a nonlinear dynamical model. Weather and climate is an example of an open system with energy dissipation. The state of such a system is modeled by a point in a phase space, the behavior of the system by a phase trajectory. After some transient process, a trajectory reaches an attracting set, the attractor, which may be a stable singular point of the system, a periodic oscillation called a limit cycle or a strange attractor. If one wants to predict the behavior of a system containing a stable singular point or a limit cycle, one may observe that the divergence of nearby trajectories appears not to be growing and may even diminish. In this case, a whole class of initial conditions will be able to reach the steady state and the corresponding systems are predictable. An example is an ecological system with periodic trajectories of prey and predator populations modeled by nonlinear equations. The divergence or convergence of nearby trajectories can be measured numerically by the so-called Lyapunov exponent, that indicates the exponential average separation or approximation of orbits and trajectories in the phase space while plotting or mapping the mathematical model of a complex, nonlinear and dissipative system[104].
A phase portrait of a nonlinear system may have a number of attractors with different regions ("separatrixes") of approaching trajectories. For forecasting the future of the evolving system it is not sufficient to know all the possible attractors and the initial state. What we need to know in addition are the separatrixes for attraction basins of the different attractors. If the initial state of a system happens to be far away from the basin of a certain attractor, the final state of the corresponding attractor cannot be predicted.

If the corresponding Lyapunov exponent is positive, the behavior of the system is chaotic. If it is zero, the system has a tendency to bifurcate. If it is negative, the system is in a stable state or branch of the bifurcation tree. In this case the system is predictable. In the other cases the sensitivity to initial conditions comes into play. It is remarkable that a nonlinear system in the chaotic regime is nonetheless not completely unpredictable. The white stripes or "windows" in the bifurcation diagram indicate local states of order with negative Lyapunov exponents. Thus, in a sea of chaos we may find predictable islands of order. In this case the system is at least predictable for characteristic short intervals of time.

[104] On the Lyapunov exponents, see: http://epidem13.plantsci.cam.ac.uk/~kbriggs/

In general, the degree of predictability is measured by a statistical correlation between the observed process and the model at the particular time since the start of the observation. Values close to unity correspond to a satisfactory forecast, while small values indicate a discrepancy between observation and prediction. Every forecasting model has a certain time of predictable behavior after which the degree of predictability decreases more or less rapidly to zero. With improvement of the model the time of predictable behavior may be enlarged to some extent. But the predictability range depends upon fluctuational parameters. Weak microscopic perturbations of locally unstable chaotic systems can reach a macroscopic scale in a short time. Thus, local instabilities reduce the improvement of predictable behavior drastically.
The predictability horizon of a forecasting system means a finite time-span of predictable behavior that cannot be surpassed by either improved measuring instruments or a refined prediction model. When we remember that the atmosphere is modeled, following Lorenz, by nonlinear systems with local and global instabilities, we realize the difficulties encountered by meteorologists in obtaining efficient long - or even medium-term - forecasting. The belief in a linear progress of weather forecasting by increasing computational capacities was an illusion of the 1950s.

As nonlinear models are applied in different fields of research, we gain general insights into the predictable horizons of oscillatory chemical reactions, fluctuations of species, populations, fluid turbulence, and economic processes. The emergence of sunspots, for instance, which was formerly analyzed by statistical methods of time-series is by no means a random activity. It can be modeled by a nonlinear chaotic system with several characteristic periods and a strange attractor only allowing bounded forecasts of the variations.
In nonlinear models of public opinion formation, for instance, we may distinguish: a) a predictable stable state before the public voting (“bifurcation”) when neither of the two possible opinions is preferred; b) the short interval of bifurcation when tiny unpredictable fluctuations may introduce abrupt changes, and c) the transition to a stable majority. The situation reminds us of growing air bubbles in turbulently boiling water: When a bubble has become big enough, its steady growth on its way upward is predictable. But its origin and early growth is a question of random, stochastic fluctuation.
Today, nonlinear forecasting models do not always deliver better and more efficient predictions than the standard linear procedures. Their main advantage is the explanation of the actual nonlinear dynamics in real processes, the identification and improvement of local horizons with short-term predictions. But first of all an appropriate dynamical equation governing an observation in the future must be reconstructed, in order to predict future behavior by solving that equation. Even in the natural sciences, it is still unclear whether appropriate equations for complex fields such as earthquakes can be derived.
To make an exhaustive search for all possible relevant parameters, a learning strategy may start with a crude model operating over relatively short times and then specify a smaller number of parameters in a relatively narrow range of values.

An improvement of short-term forecasting has been realized by the learning strategies of neural networks. On the basis of learned data, neural nets can weight the input data and minimize the forecasting errors of short-term stock quotations by self-organizing procedures. As long as only some stock market advisors use this technical support, they may do well. But if all agents in a market use the same learning strategy, the forecasting will become a self-defeating prophecy.

The reason is that human societies are not complex systems of molecules or ants, but the result of highly intentional acting beings with a greater or lesser amount of free will.
A particular kind of self-fulfilling prophecy is the Oedipus effect in which people like the legendary Greek king try, in vain, to change their future as forecasted to them[105].

From a macroscopic viewpoint we may, of course, observe single individuals contributing with their activities to the collective macro-state of society representing cultural, political, and economic order ("order parameters"). Yet, macro-states of a society, of course, do not simply average over its parts. Its order parameters strongly influence the individuals of the society by orientating their activities and by activating or deactivating their attitudes and capabilities. This kind of feedback is typical for complex dynamical systems. If the control parameters of environmental conditions attain certain critical values due to internal or external interactions, the macro-variables may move into an unstable domain out of which highly divergent alternative paths are possible. Tiny unpredictable micro-fluctuations (e.g., actions of very influential people, scientific discoveries, new technologies) may decide which of the diverging paths in an unstable state of bifurcation society will follow.

3.10 Conclusions

The complexity and chaos theory is an area of mathematical research that attempts to characterize, predict, and explain the phenomena that in appearance exhibit complex and -often- random behavior. It also aims at discovering the mechanisms through which this behavior can be deterministically generated based on simple differential equations that require few levels of freedom. On the other hand, it reveals an ontological foundation for the knowledge process that greatly differs from that modern science and strangely resembles some pre-modern assumptions. Predictability loses efficiency as a tool of the

[105] According to Greek mythology, Oedipus was the son of the King of Thebes, Laius and Jocasta. Warned by the oracle that his son would kill him, at the birth of Oedipus, his father ordered one of his servants to kill the infant. The servant, however, took pity on the newborn and abandoned the baby, tied to a tree in Mount Cyther, where he was found by a pastor who took him to Polybus, King of Corinth. The king adopted the baby and educated him as a prince. As an adult, Oedipus consulted a fortune-teller who told him never to return to his fatherland because his fate was to kill his father and marry his mother. Not knowing any other land but Corinth, he banished himself. On his arrival in Thebes, a carriage crossed his path and there was a dispute during which Oedipus killed the driver and his slave, thus fulfilling the first part of the prophesy, since the man in the carriage was his real father, Laius.
At that time, the sphinx, a woman-headed monster with the body of a lion and the claws of an eagle, was devastating the outskirts of Thebes, devouring anyone who proved unable to solve its riddles. Creon, successor of Laius, had promised the throne and his sister Jocasta in marriage to the man who could free his country of the sphinx. Oedipus solve the enigma, was crowned King of Thebes and unknowingly married his mother, producing four children with her. Once their children were adults, an oracle gave away the secret of his tragedy. Jocasta hanged herself and Oedipus took his eyes out, left Thebes forever and was taken care of by his daughter Antigone. He died later in Attica.
Manuel Rubio Egusquiza, *Dictionary of Classical Mythology*. (Spanish edition: Buenos Aires, Librería del Colegio, 1947. page 78)

knowledge process in connection with physical, biological, and social systems as they move from stable dynamics towards unstable dynamics along the bifurcation path.
In the new complexity science, order occupies a small niche, while the variable order/ disorder rate covers the geography available to it, with emerging macro-structures whose geometry becomes so complex that research designs cannot adjust to it.
The chaos and complexity theory calls for a complete new way of thinking -one where fractal geometry replace the neat Euclidean shapes; where the truth values of propositions change depending on the region in the complex outcome basin; where the Newtonian physics is replaced by discontinuity and qualitative change; where Newtonian calculations give way to qualitative mathematics; and where the second law of thermodynamics is considered to describe only half natural and social systems' fate, since new and unpredictable forms of order emerge from the other half.
Most of the issues around modern sensitivity are centered around the fact that two similar systems can find very different destinies; that contradictory outcomes are in the same complex causal basin; and that causal relations change as a systems changes from a dynamical area to another.
Even simple systems can exhibit complex behavior. What is true in a scale of observation can be totally incorrect in another. What is true for natural and social systems' dynamics in a phase-space region is not true for another. The values of truth themselves are fractal in that science.
In chaos theory, the variation around a key tendency and the qualitative change from a dynamical state to another will be found in the system's *interactions.*

One or more attractors operating in the system control the patterns formed by non-linear systems. When these patterns are complex, we talk about a "strange" attractor, as in the case of fractals. According to Thomson[106], it is these attractors that develop the patterns of the human psyche that define individual behavior.

A strange attractor behaves as a gyroscope, keeping a certain type of psychological typology as determinant, depending on the personality traits. External forces, such as stress, can act on the strange attractor, forcing the typology to temporarily modify its pattern. When the effect of stress weakens, as in a gyroscope, the pattern goes back to a state close to normal.

One of the most surprising conclusions in the Chaos Theory is that there is a good chance that a very simple process be the cause of a really complex pattern. However, this does not mean that we can conclude that its consequences are easily understandable[107].

As regards the social aspect, the first order change can be justified by differences between individuals. But second and third order changes derive from interactions among two or more variables interacting in an outcome basin instead of the differences between members of a series. It is not that new variables participate, but small changes in existing variables produce qualitatively new behavior patterns; some of them are different from those of the previous attractor. Water molecules in an equilibrium state are not qualitatively

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[106] H. Thompson, "The Strange Attractor Within". In *Bulletin of Psychological Type*. (vol.19. 1996) pages. 34 - 35.

[107] H. Peitgen, H. Jürgens and D. Saupe, *Chaos and Fractals: New Frontiers of Science*. (New York, Springer Verlag, 1992)

different from water molecules in a more chaotic state. The same happens with trout, nightingale, grasshopper, heartbeats or human beings. Small changes in key parameters of a greater area that can actually produce a qualitative change, not necessarily an external agent, a new pathogen. Thus, regardless of a change in the genetic or psychological organization, human or social systems can adopt different life courses depending of the dynamics of variables outside the system.
At the edge of a causal area, small differences in the way we act, think, and feel interact to drive an individual or group of individuals to a very uncertain fate. In complex causal areas, interactions can create completely new forms of order and certainty. The more complex the system, the more likely to become irrational in a technical sense. The application of chaos and complexity theory shows its benefit in the story of the encounter of order versus disorder, precision versus pattern, certainty versus randomness, fate versus luck, truth versus fiction.

The chaos theory calls for a thorough and extensive review of the basic assumptions that guide the knowledge process in research and theory although it upholds and respects the contributions made by traditional sciences. Modern science is still the foundation for the knowledge process; however, it has changed to take a greater commitment to the whole causal area of the system under study. In this sense, the usefulness of the epistemological analysis is increased by the concepts of wholeness and synthesis.

Fourth Part: Rumor in the Light of Chaos Theory

“The life of the modern man is devoured by the hunger for novelty”
Martin Heidegger

“The question as to where complexity comes from is the wrong question. A much more important question is why simplicity exists there”
Jack Cohen and Ian Stewart (The Collapse of Chaos)

As we have seen, although the complexity and chaos theories stem from physics and mathematics, they can be applied to social sciences. However, one of the usual objections is that, since chaos is considered deterministic, it does not take into account freedom as a factor of human development in connection with freedom of choice. Yet, this is not so. When theory is supported by determinism, it is considered to be opposite to randomness. But in fact it is not that freedom does not exist; on the contrary, chaos results from the high levels of freedom within the system. It is deterministic and not random because if all and each systems' parameters and variables were known, the mathematical model should "run" and show a certain result. The problem is that in a complex dynamical system, it is practically impossible to know all the values: the more complex the system, the more the model derived from such system should resemble itself.
Again, the point here does not lie on the options that the individual has to take his decision, but rather what is being stated is that if all the variables of the individual and his options were known, the model should indicate which of the options the individual will finally select; therefore, from the point of view of the model, his option would be deterministic[1].

As will be seen at the end of this chapter, the variables and parameters that should be known to determine a mathematical model of rumor are numerous and very difficult to determine. Since rumor is volatile -its most peculiar characteristic- it is very difficult to record; therefore, it is difficult not only to study rumor but also to determine its mathematical model. Consequently, it is more realistic to analyze rumor by applying chaos and complexity theory in terms of metaphors.

4 Complexity and Chaos Theory Metaphors and Models Applied to Rumor

We are familiar with the concept of language as a means of communication, but its role goes beyond that. Putting the formulation of an abstract problem into words and elaborating its description and useful statements is part of the same creative mental process.
One of the essential aspects of problem statement and solving is the correct use of language. If the adequate words are available, we can see further and perception reaches a higher level.
A well known observation of the Inuit language illustrates this idea: Esquimoes count with several words to define snow. Instead, we have just few words and we therefore perceive few types of snow. Esquimo kids who learn all these words can distinguish several types and see all types of snow.

In natural sciences, the term "model" often refers to mathematical objects, which we use to study. For example, a simple model as the square or logistic equation models the limited

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(Many of the notes correspond to texts in Spanish. English versions of those texts are most likely available)

[1] "Chaos exists when the long-term prediction of a system is impossible because uncertainty in a system's initial state grows exponentially fast over time."
Brown, Thad A.: Nonlinear Politics. In: Kiel, L.Douglas y Elliott, Euel: *Chaos Theory in the Social Sciences*. Foundations and Applications. The University of Michigan Press, 1999. Page 119).

growth of a single population as a culture isolated in a laboratory or a rabbit population isolated on an island. The term “model”, however, is used in several other manners. A teacher may use the term for synthetic constructions of a regular polyhedron, a human skeleton or organ. A biologist or medical researcher can use a relatively simple experimental structure as a model for a complex phenomenon of real life. The use of the term “model” with so many different meanings can be confusing in this respect.

Mathematical concepts are expressed in a language describing ideas, statements and structures. Due to the strength of the mathematical thinking and its surprising effectiveness in mathematics and its applications, this language plays a major role in those fields that allow for a more or less precise treatment, such as natural sciences and economy.

The idea of a “model” and of “modeling reality” is familiar to mathematicians. In their abstract world, they can imagine what modeling is about. However, the use of metaphors and their essential role in scientific thinking is less known.

The term “model” is used here as a schematic presentation of reality that connects the main quantities through equations that are mathematically shaped laws. In this formulation, models are mathematical models; they pose extremely difficult qualitative questions, and at the same time their nature is essentially quantitative. When numbers and figures are produced, we obtain an as accurate as possible quantitative approximation to reality.

Mathematical models should never be mistaken for the reality itself; they only represent a simplified vision of an artificially isolated portion of reality.

Models as used by science have qualitative and quantitative aspects; metaphors are purely qualitative. That is why metaphors are more adequate for those disciplines where a quantitative approach makes little sense. In addition, even the most sophisticated mathematical models used in natural sciences are only metaphors with added quantitative elements. Again: although these models describe reality, they are not to be mistaken for it.

In everyday language, in scientific analysis and theories, metaphors are inevitable. According to Aristotle, a metaphor is “giving something a name that belongs to some other thing”. It is impossible to describe and theorize about new things without referring to known things. We can only understand or place something if it is or resembles something we already know.

Think of the expression “natural selection” that has been used since Darwinian times to indicate change and survival of species. It is obvious that nature is not a person and cannot select. Another example is the computer with its “memory”; a better expression would be “data storage device”, but who would take it seriously? The computer “reads”, “stores”, “uses a language”. They are a few examples of the power of metaphors.

The Complexity and Chaos Theories give us a number of new metaphors such as self-organization, strange attractor, fractals, etc., that may occur in any type of discipline. There are examples of the use of these metaphors in meteorology, biology, politics, environmental studies, and many others. The use of language in these fields adds value, it triggers new ideas, and permits us to perceive phenomena previously left aside. New and well-selected metaphors lead to new ideas which, in turn, lead to new perceptions of reality.

Social sciences, especially psychology, resort to numerous metaphors that derive from mechanics. Examples include problem “displacement”, a well “balanced” or “stable” person, a “divided” personality, etc. These metaphors have become so common that they are used as if they belonged to these disciplines. In the relatively new science of social

communication, natural sciences' metaphors are basically limited to the legacy of Shannon's information theory[2] and Shramm and Wiener's works[3].

The purpose of this chapter is to apply concepts in Complexity and Chaos Theories to communication and rumor as asocial phenomenon, and to lay the foundations to design a mathematical model of rumor as a non linear, dynamical and dissipative system, drawing parallels with other similar systems and exemplifying some of the most characteristic attractors.

4.1 Chaos and Communication

Communication researchers have systematically sought means to explain, control and predict communication behavior between people. For many reasons, the accuracy of constructed models and the studies based upon them has not risen very high. It can be claimed that the reasons for the inaccuracy of communication models, and thus the poor predictability of everyday actions, originate from the processes' innate chaos, apparent beneath their behavior. This leads to the argument that communication systems, which appear stable and have precisely identical starting points and identical operating environments, can nevertheless behave in an exceptional and completely different manner, despite the fact that their behavior is ruled or directed by the same rules or laws.

Finnish communication researcher Osmo A. Wiio's first law of communication, according to which communication fails except by chance, is the stochastic model of communication dynamics[4]. Many phenomena of communication include factors which seem random, and these factors might be regarded as stemming from errors in measurement or merely intractable disturbances in the process, and thus may leave them outside the results considered as characteristic of the utilized linear sender-centered models. A process in which event A affects event B which affects event C which in turn affects D, and so on, has the characteristics of a linear deterministic system. If D leads to event A, the system forms a circle, which behaves in a completely different fashion.
We can examine communication as an occurrence which is a bifurcation formed by different unfulfilled possibilities, in other words, as a chain formed by potential or realizable alternatives. Communication is ruled by non linear characteristics when the present cannot be returned to the past; development is thus dissipative because conclusions cannot be drawn from events happening at this moment nor can the past be predicted because it is not possible for us to know which the new initial conditions will be in a non-linear dissipative model when we re-run it from the beginning. In any communication process

[2] C. Shannon y W. Weaver, *The Mathematical Theory of Communication*. (University of Illinois Press, 1949).

[3] Wilbur Schramm, *The Process and Effects of Mass Communication*. (University of Illinois Press 1954) and Wilbur Schramm, *The Science of Human Communication*. (University of Illinois Press, 1963).
N. Wiener, *Extrapolation, Interpolation and Smoothing of Stationary Time Series*, (Cambridge, Ma, MIT Press, 1949)

[4] O.A. Wiio, *Wiion lait ja vhn muidenkin*, (Weilin+Göös, Espoo, 1978), Cited in W. Sulis & A. Combs (Editors), *Studies of Non-linear Phenomena in Life Sciences (vol 5): Non-linear Dynamics in Human Behavior*, (London, World Scientific Publishing Co. Ltd., 1996), Pages 191.

there are perturbations that occur when previous explanations and the understanding of the state of affairs are not true any longer.

Chaos theory studies non linear systems, believed to be stable but whose behavior can nevertheless change by surprise from dynamic balance to non-balance (edge of chaos) and develop towards increasing disorder (complex and random) ruled by a fundamental order. This higher order behind apparently disorderly behavior is the focus of complexity and chaos theory.

A chaotic phenomenon is unpredictable, and precise information about its development or future final state cannot be obtained. However, the process of chaos is not dependent on chance. Instead it develops within a unique chaotic path (i.e. a strange attractor) which has determined boundaries. Chaos theory provides a dynamic conception of a reality, which understands the behavior of phenomena as complicated or unpredictable, but still law obeying.

As seen in the previous chapter, by applying chaos theory we can build different behavior patterns of dynamical human relationships, and communication processes are closely related to human behavior.

The problem with communication analysis from this perspective is that the models based on the main paradigm of linear traditional communication (sender-centered) are not enough to describe, explain, and predict individuals' communication. P. Aula[5], professor at Communication Department of Helsinki University, believes that the reason for the scarcity of existing communication models derives from the inherent complexity of communication phenomena and processes; they sometimes behave chaotically since their properties characterize dynamical systems: non linearity, sensitivity to changes, and unpredictability.

Shannon and Weaver's Mathematical Theory of Communication[6] has been one of the most important and authoritative in the development of later communication process models and theories. Regardless of the model's omissions and deficiencies, it has remained as perhaps the longest-lasting description of the communication process. The model is, by nature, a linear sender-centered communication model, and its effect on the development of communication models as well as by the way by which communication is understood, has been monumental.
In spite of its notable contributions to the study of communications (including the measurement of the quantity of information by bits and the understanding of entropy as applied to communication), Shannon and Weaver's model is in itself a derivative of communication's main linear paradigm:

$$A \rightarrow B = X$$

A communicates something to B, with X as a result

[5] P.S. Aula, *Chaos and the Double Function of Communication*, in W. Sulis & A. Combs (Editors), *Studies of Non-linear Phenomena in Life Sciences (vol 5): Non-linear Dynamics in Human Behavior*, (London, World Scientific Publishing Co. Pte. Ltd., 1996), Pages 191-206.

[6] C. Shannon and W. Weaver, *The Mathematical Theory of Communication*. (University of Illinois Press, 1949)

Shannon and Weaver's theory is linear and it is associated with the balancing and strengthening of a system's structure. Only one direction is possible, that is towards balance. Similarly, new information is also in the first place centered on the strengthening of already existing information structures. The amount of information is taken as given; due to inevitable disturbances it can only diminish.
As heirs to the theory of Shannon and Weaver, we can mention, for example Westley and MacLean's model[7], Rogers and Shoemaker's diffusion model[8] as well as mass communication news flow, gatekeeper and uses-and-gratification models. These models are more rational that a human being himself. Residual values, stochastic errors or human factors are abstract explanations of deviations from the linear model and most often they seem to be the receiver's mistake.
All these models include the linearity of existing order; however, we can see that these theories verbal descriptions often attempt to handle prevailing non linear relations within the communication system. Perhaps the problem is not the accuracy of the explanatory observations of behavior but the properties of the models employed for the explanation.
Anyway, what is actually evident is that from the Chaos Theory perspective, Shannon and Weaver's model is insufficient to describe the dynamical and complex processes of human communication.

Since the organizational communication system, as that of companies, is a clear example of a system formed by given formal communication channels -with communication structures and rules- and informal channels, an interesting analysis is possible from the Chaos Theory perspective.

According to Robbins, "an organization is a consciously coordinated social unit, composed of two or more people, that functions on a relatively continuous basis to achieve a common goal or set of goals." [9]
Organizational communication is two-way interaction that makes possible in different situations the realization of the goals of the organization and its members. Communication joins the parts of the organization to each other and also to the organization's environment.
Processes can be found among the different fields of organizational communication, which are exposed to the butterfly effect. The constructing of communication relations, the spreading of unofficial information, changes in public opinion, chains of association, the adoption of new innovations, and so on, are in their many forms and in their unexplainability comparable, for example, to the unpredictability of the weather system.
Many communication events can be presented as periodic systems, in which the output of the last event is the input of the following. Small and seemingly insignificant changes on the micro-level appearing in communication can grow in strength, which effects the macro-level organization. For example, increasing uneasiness among employees derived from the manifest complaint of one of them who is dissatisfied with his compensation: the employee's complaint spreads through all the staff (with a level of latent discomfort) and

[7] P.S. Aula, *op. cit.,* Page 194.

[8] P.S. Aula, *op. cit.,* Page 194.

[9] S. P. Robbins, *Organizational Behavior. Concepts, Controversies and Applications*. (New Jersey, Simon & Schuster, 1991).

ends up, for example, in a strike. The crisis produces a first order change in the system (butterfly attractor or effect).

It is important that any system which is susceptible to the aforementioned effect, can in a short space of time, change its nature unpredictably. Thus, chaoticity is an inherent property of a system.

Organizations working in society often change due to environment-changing factors and it is apparent that an organization is often subject to pressures of change from the environment. In other words, companies change not only because they are forced to do so by competition but also because both the rules of the game and markets often change. The system's growing structural instabilities, the loss of control or the absence of resources due to environmental turbulence can cause a critical state or conditions for the organization, which can be called the bifurcation point. Normally, a rational organization tries to stabilize or balance its behavior by different methods. It attempts, for example, to cultivate its structure and to increase its capacity to process information, or to increase its openness to the possibilities offered by the changed environmental conditions. If the change cannot be controlled, the organization's instability may begin to grow cumulatively toward chaos; actions made within the organization can surpass the next effective operational level, causing again a new wave of change.

It is self-evident that the predictability of the behavior of an organization is vital for effective planning and management. There is thus reason to ponder on what conditions an organization can be put on a level with a potentially chaotic-behaving system. We can identify certain features, which all chaotic systems have in common:

1. Chaos appears in non-linear, dynamic systems,
2. Chaos appears in systems which are recursive (positive feedback), by which is meant cycles in which a system's output at a given moment is used in the input of the following moment.

It is easy to see the primary characteristics of these features, for example in present-day firms and other organizations and for their functioning environments.

Recursiveness plays a large role. Prepared plans are based by rule on the previous period's achievements and lessons are sought from the past. In practice, nearly all methods are composed of activities that the members of the organization try to improve through a recursive and self-organized process. On the other hand, sudden and irregular and unforeseeable changes in the functioning of an organization can be, for example, the failure of the operation plans, the interruption of production, a surprise strike and internal conflicts. In other words, an organization can be determined as a comprehensive communication system whose behavior is at all times susceptible to chaotic phenomena. Bearing in mind these features, one can examine an organization's ability to control change caused by environmental or internal factors.

As a simple model for discerning changes one can use, for example, the familiar formula:

$$A\,(t + 1) = E\,(t) - E\,(t)^2 \qquad (2)$$

(The formula is similar to $x(t+1) = rx(t)\,(1-x(t))$, known as Verhulst equation[10]. In 1976, May[11] noted that it is possible to use similar functions in social sciences. Equation (2) is $x(t+1) = rx(t)^2$, x is replaced by symbol A and rx by symbol E).

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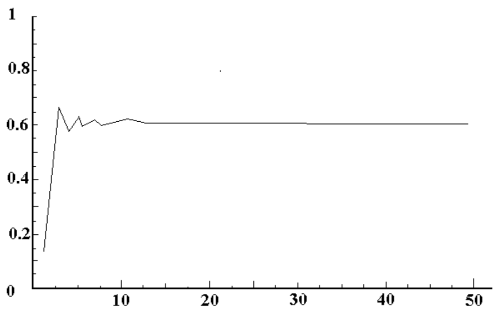
[10] F. Verhulst, "Metaphors for Psychoanalysis", *Non-linear Science Today*, (Springer- Verlag, Vol. 4 Nº 1, 1994).

Symbol A presents the organization's ability to control complexity, and E the change in environmental factors occurring in time (t). The organization thus has certain possibilities A to control environmental turbulence during a specific period of time. As environmental pressures increase, that is as E increases, the organization's behavior also acquires new forms. Controlled change can, however, get out of hand; the functioning change may be chaotic thus paralyzing and possibly destroying the system completely. The resulting graph would be similar to that of population growth:



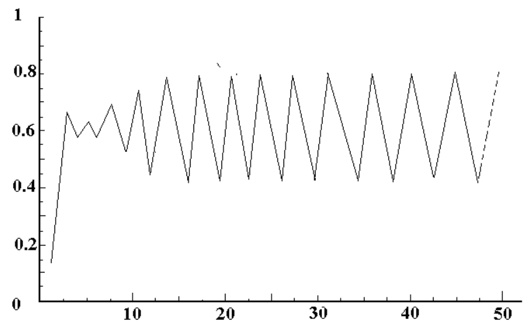
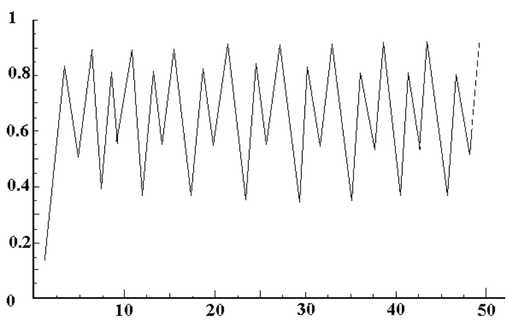


Figure 1: at the value E = 2.5 the system maintains equilibrium
Figure 2: at the value E = 3.15 behavior divides and the system oscillates between two different values



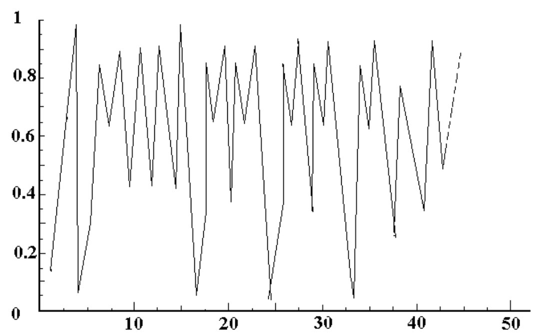


Figure 3: at the value E = 3.55 behavior divides again and oscillates between four different values
Figure 4: at the value E = 4 the system's behavior has divided many times and becomes chaotic

In practice, one can specify the system's oscillations between different values by examining it as an expression of the changed behavior in relation to the environment.
The behavior of the organization represented in figure 1 is stable. Its operations are in balance with the new conditions and demands of the environment, and random conditional changes occurring in the environment do not cause changes in the organization's behavior.

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[11] R.M. May and G.F. Oster, "Bifurcations and Dynamic Complexity in Simple Ecological Models", *American Naturalist*, (110: 573-99, 1976)

In the situations of figures 2 and 3, the effect of the environment causes periodic change in the system's behavior, which is nevertheless controllable. The system in figure 4 never achieves a stable level of operation in relation to its environment, but the variation still remains within the specific limits of the chaotic attractor.

A better understanding of the pressures surrounding an organization can be achieved if we use the bifurcation diagram to describe the system's behavior produced by the formula. The diagram in figure 5 is called developmental behavior model of the chaotic system.

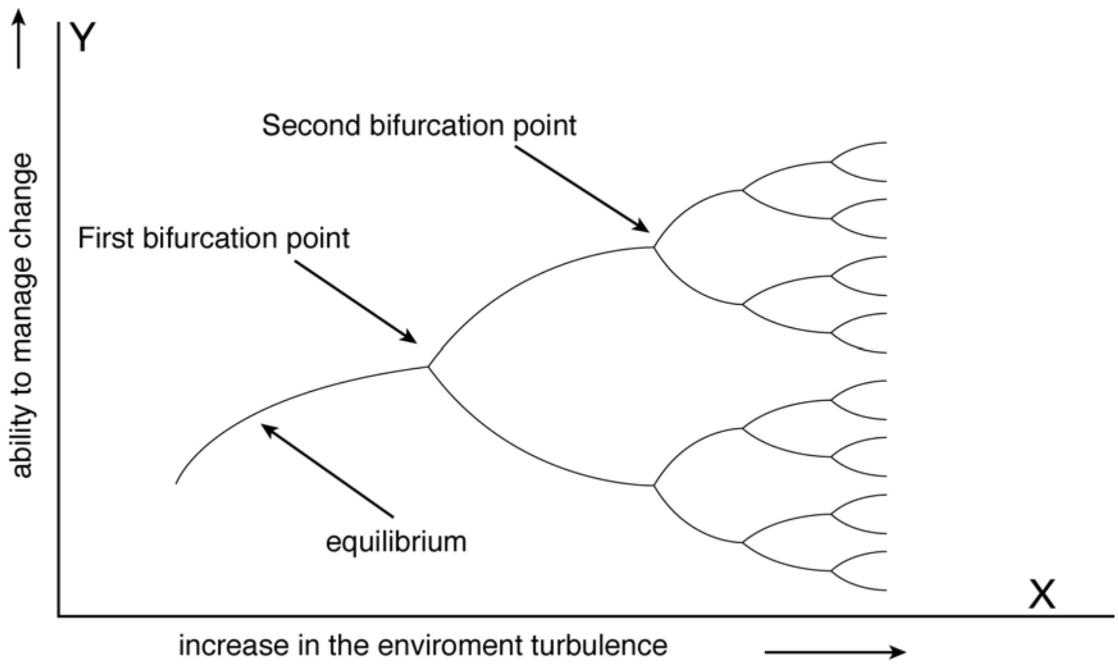

Figure 5: Behavior model of a chaotic system (simplified due to observability)

Again, the organization's ability to manage change is presented by the y-axis and the changes in the environmental conditions by the x-axis. For every E value a point is drawn on the graph, which presents the state corresponding to the system's balance. The pressures due to the environment being few, the system's structure is not changed. With growing pressure the system moves towards the first doubling, which is the first bifurcation point. Behavior changes from stability to balance to disturbance and variability. If the pressures of the environment continue to increase, the strength of the disturbance factors increase and management becomes more difficult, leading to the situation in which behavior becomes even more complicated and hard to control. The organization is headed towards chaos. It can try to minimize instabilities at the bifurcation point with the help of communication or control (i.e. the system's operational subsystem) when it chooses the right path of development. In connection with every realized choice, the organization moves towards new points of communication space (phase space) along the path it has created.

Communication as a sub-structure of an organization can be an effective tool in the safeguarding of correct choices and the realization of favorable development. Since control is not an independent system and can itself be unbalanced or chaotic, it is clear that not just any communication is system-productive or integrative. Communication can

be regarded as a qualitatively bi-sectional system in which one part -integrative or homeostatic- directs the superstructure towards order and the other –dissipative or entropic - towards growing disorder.
These double function is visualized in the following figure:

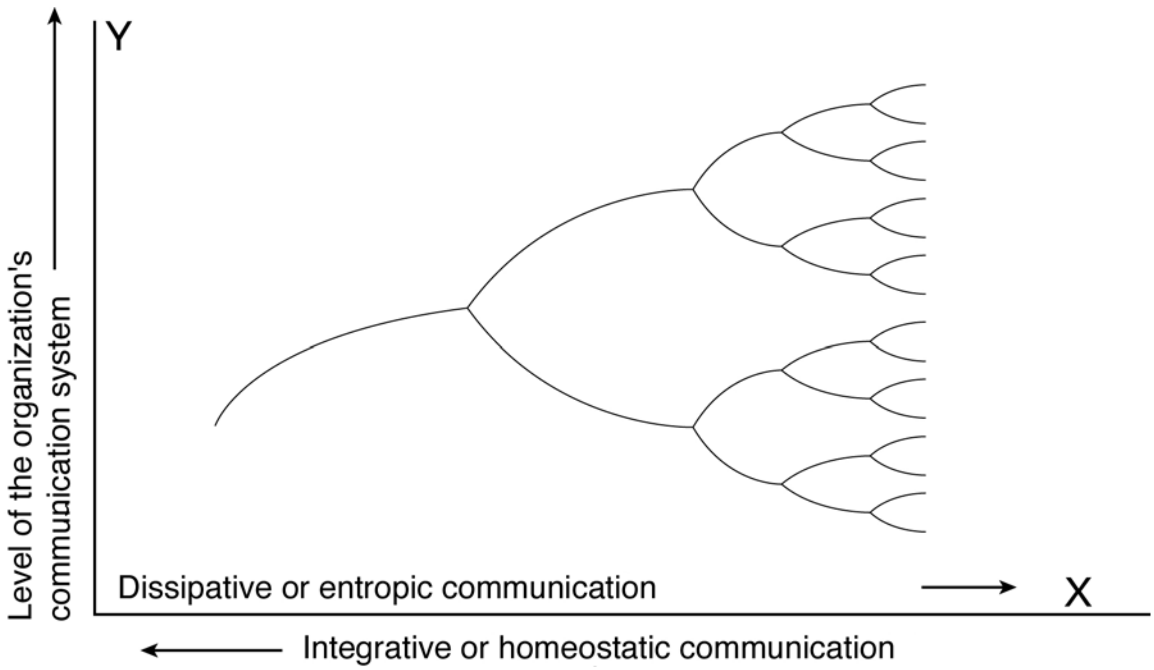

Figure 6: The meaning of integrative and dissipative communication for the structuring of the organization's communication system

Effective integrative communication would thus be the organization's important instrument when it meets with pressure for change from the environment. On the other hand, dissipative communication works in reverse; it makes harder the organization's choice made in bifurcation. It can even become damaging and direct the organization towards the wrong development path.

It can thus be claimed that every communication act realized within an organization is by its nature bipartite, and that communication can simultaneously carry out two different functions.

In his thesis, Aula[12] states that every communication event, regardless of its original meaning or appearance, is simultaneously both integrative (constructive) and dissipative (destructive). At the optimum level, an organization's communication would be directed so that the communication's integrative properties would be maximized and its dissipative properties minimized. On the other hand, if the destruction of existing structures and functions is being sought, e.g. to force a structural or organizational cultural change, the implementation of controlled dissipative communication can be adequate.
It is with regard to the improvement or rationalizing of the organization's operations that this concept of double function has its advantage. Its realization, that for example all

[12] P.S. Aula, *op. cit.*, Page 201.

communication occurring in every stage of a delegation process can work in two different ways regardless of what meaning it had designed, offers superior possibilities to better control communication. A talented superior constructs his message in such a way that its are of effect is as broad as possible. The appearance of the communication is not decisive, according to Aula, but rather the relation between the integrative and dissipative functions, which also depends on the receiver of the message, on his worldview, his attitude and his mood (motivation).
The interpretation of the message is facilitated by the realization of its double function. This idea applies in both individual as well as group delegations. It could be said that in delegating tasks to a group, the significance of the realization of communication's double function grows. There are more people in a group and thus more chances of a wrong interpretation. In extreme circumstances, the message can be integrating to one of the group members and to another dissipative, again regardless of the message's nominal meaning or content. What counts is the meta-message (the meaning "between the lines").

In practical group situations, the benefit of communication's double function could give room to the free forming of the group's structure. Successful free communication, which is a necessary condition for the synergy rising from the group, makes possible a lively group and opens the road to change. Ossified structures are broken and self-organization surfaces as the main property of the group's functioning. In such a case, the significance of interactional communication grows; continual interactive exchange between members is necessary, if the double function in a communication situation is to work in the desired manner. The common knowledge of the actors of the communication process, shared meanings, empathy, cultural interaction, all are important to group communication and thus also to the group's functioning.

Communication and a control system's structuring to the level that makes possible the effective functioning of the main system (organization as a whole), is not identical with the traditional balance concept of the communication system. As an independent system, the communication system continuously changes, for example in its relation to its environment at least on the micro-level; neither are the dynamic communication relations ever structurally stable. The traditional balance between an organization and the environment is an artificial concept used as an aid to modeling; its appearance in organization reality is impossible.
The traditional balance concept of organization models builds a protecting shield around the organizations, in the sense that even after a dramatic change it ensures a return to a safe and often more effective homeostatic state of stability. Balance from the perspective of complexity and chaos systems makes an organization susceptible to disturbances and sudden changes when the organization itself seems to stand on a firm surface. It is important to note that the seemingly random disturbance or bias in an organization's operation perhaps does not have to be a deviation from the state of balance which can be corrected, but instead a characteristic of the organization's fundamental nature.

From the perspective of Complexity and Chaos Theory, the example described presents a few general assumptions about the organization's characteristics and thus about the comprehensive communication system's nature and behavior[13]:

[13] P.S. Aula, *op. cit.,* Page 203.

- A communication system develops from dynamic and nonlinear elements, which are in a recursive interactional relationship with each other.

- From the communication system's development we can distinguish stable behavioral stages (the chaotic balance) and crisis points (the bifurcation points). The changes of the stable period are to a certain degree predictable, whereas this is impossible at the crisis points.

- In the development of communication systems, sudden and unexpected changes appear which change it qualitatively and lead the development to a completely new level. The uncontrollable development of a communication system can lead to chaos. The significance of qualitative changes is as important, if not more important, than quantitative changes.

- Integrative communication realized in a communication system directs the system towards stable forms and dissipative towards disintegration. The double function of communication works in a way as a balancer and director of behavior in a system's development between order and disorder, i.e. edge of equilibrium state.

In an organization's communication research, chaos theory highlights the problems involving the measurement of the communication effectiveness and influence. Observations, measurements and calculations are always imprecise, which also leads to inaccuracies in conclusions and predictions. According to the butterfly effect, mistakes and non-specifics can grow cumulatively and arbitrarily rapidly. However, the behavior of chaotic systems is at all times completely pre-determined, i.e. deterministic. Unpredictability is merely the result of the fact that no finite information is enough to describe the system so precisely that the prediction will not in a short time become worthless. We can say that the more precisely the system's condition is known, the more precisely and long-term a prediction can be made, albeit only to an extent. What can be done? Although the behavior of communication systems cannot be predicted absolutely, it can still be influenced in the desired direction.

With regard to chaos in the development of a system, we can limit it by controlling the parameters. Similarly, by changing the system's structure and properties we can stretch the plan of chaos and create so-called slow chaos. Thus, in place of single predictions and precise measurement, for the behavior of the organization we can construct alternative scenarios, which are checked and corrected as conditions dictate.

4.2 Entropy in Communication

The definition of information according to the theory of information is in function of its capability to reduce uncertainty or disorganization of a situation on the recipient side. This premise derives in two fundamental concepts: entropy and redundancy. Entropy means, as seen when analyzing the General Theory of Systems, uncertainty or disorganization of the system, whereas redundancy is just the opposite.
Entropy is measured in function of the information required to eliminate uncertainty or randomness of a situation within one or two systems. It is obvious that entropy will reach its maximum level when all the states of the system are equally probable, i.e. when they are produced randomly, as when flipping a coin.

Redundancy is a measurement of certainty or possibility of prediction. In the information theory, as well as in social communication, the more redundant the information system, the least information is transmitted within a given period. On the other hand, without redundancy, any language or code will prove chaotic. In many cases, the increase in redundancy increases communication's efficiency[14]. In this sense, "economical" communication is not always the most efficient. A reporter can explain the term "strange attractor" in two hundred words; scientist will consider it unnecessarily redundant, but it is necessary for a layman. The old empirical rule of thumb that says that the name of a product should be repeated at least three times during a radio commercial responds to the search for an optimal level of communicative redundancy.

Relative entropy is just the other side of the coin of redundancy. The lower the redundancy, the higher the relative entropy. Wilson Taylor's "Cloze" procedure, described by Shannon[15], calculates the level of entropy in message construction. Taylor eliminated words periodically from a passage of a given text, and asked readers to replace the missing words. The list of the different words suggested for each of the missing words showed how to measure the possibility of prediction for this specific audience. Thus, two paragraphs are given to the same group of 20 readers and the resulting average score is, for instance:

for paragraph A:

16	individuals	specified	the	word	A (correct).
2	"	"	"	"	B
2	"	"	"	"	C

for paragraph B:

6	individuals	specified	the	word	A (correct).
4	"	"	"	"	B
3	"	"	"	"	C
1	"	"	"	"	D
1	"	"	"	"	E
1	"	"	"	"	F
1	"	"	"	"	G

These results show that B's relative uncertainty or entropy is considerably higher than A's for this group, which is seemingly more redundant than B. Taylor showed that a message's relative redundancy or entropy is closely related to its legibility. The same could be said for a message's oral transmission. The higher the number of a message interpretations, the higher the level of entropy or uncertainty for this message to be interpreted as the sender had intended to. In other words, univocality is inversely related to entropy. The more univocal, the more redundant and the less entropic.

On the other hand, it is evident that the level of entropy of a newspaper or radio station is much higher than that of traffic lights. The newspaper or radio station have a higher level of freedom to do different things and to generate different products. As in the pendulum, traffic lights have only two levels of freedom (green = go ahead; red = do not pass).

However, social communication media do not exercise all the freedom at their disposal. Total freedom means a completely random content, i.e. chaos. "The art of a TV or radio

[14] Wilbur Schramm, *The Science of Human Communication*. (University of Illinois Press, 1963).

[15] C. Shannon and W. Weaver, *op. cit.*

program manager is to find the perfect balance between predictability and uncertainty; perfect balance is the best combination of satisfied anticipation and surprise”[16] .
According to Schramm’s research, mass media relative entropy fluctuates between 40% and 60%. Why do they use approximately half the freedom at their disposal to represent different news sources? One of the reasons, he says, is its space availability; however, the main reason is media directors’ definition of what the audience or readers can or want to absorb, what they “should” know, and what media can offer within their ethical, physical and customary possibilities.

The concept of entropy can be applied in the social communication theory in connection with Wiener’s assumption: “as entropy is a way of disorganization, the information given by a message group is a measure of organization”[17]. As for information, it can be stated that the higher the disorder or entropy, the higher the information necessary to retrieve the message. For example, if a crazy publisher decided to issue dictionaries that do not follow the alphabetical order, much more information would be necessary to find a word[18].
Hayles noted that Shannon’s decision to equate expected information with uncertainty and to choose the same mathematical identity in formulas for information and entropy has been too austere. This decision has been vigorously debated in literature. The concept of information as uncertainty is semantically opposed to our intuition. Thus, some authors have suggested the definition of information as the negative difference in the observation system entropy (“negentropy”). However, it is necessary to distinguish expected information (defined as uncertainty) and observed information, that is to be positioned or given a meaning in connection with a system under observation[19].
The resulting concept of communication is highly abstract: it specifies communication as an operation generating probabilistic entropy or, in other words, communicating information. Since communication, probabilistic entropy, and information are defined as content-free, these concepts are prior to their operationalization. Probabilistic entropy can be considered a dynamical equivalent of concepts such as “level of freedom” or “dimension” in the static analysis.

On the other hand, Gubern’s thesis formulates entropy and information redundancy in the following terms: “the more probable a phenomenon, the least informative it is, and viceversa.” [20].In this sense, more probable means less uncertainty and therefore less entropy. If I say “the snow in Alaska is white”, the message is very poor as regard information-content since it is obvious and irrelevant. On the other hand, the statement “ the snow in Alaska is red” is a highly informative message due to its low probability. The principle that the more a unit implies a selection from a greater number of units and the least probable it seems given its surrounding units, the more information it contributes has allowed the quantification of a phenomenon’s level of information by measuring its statistical singularity. Whereas **H** is the amount of information and **p** the level of probability:

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[16] Wilbur Schramm, *op. cit.*

[17] Norbert Wiener, *Cybernetics and Society.* (Spanish edition: Barcelona, Ediciones 62. 1965).

[18] Miguel R. Alsina**,** *Los Modelos de Comunicación* (Madrid, Editorial Tecnos. 1989).

[19] N.K. Hayles, *Chaos and Order: Complex Dynamics in Literature and Science*, (Chicago, University of Chicago Press, 1991).
C. Shannon and W. Weaver, *op. cit.*

[20] Román Gubern, *Mensajes Icónicos en la Cultura de Masas*. (Buenos Aires, Editorial Lumen. 1974).

$$H = - \log p$$

Obviously, this principle is applicable to rumor; since we can say that the more innovative (entropic), more unusual its content, the more interest will be aroused in its recipients. Conversely, once its communicative quality has been known, its information value (due to redundancy) will gradually decrease. According to Koehler, the explanation is twofold: first, after iteration (redundancy), the message loses the characteristics of its first phases. Second, time and the action of new stimuli (messages) modify the individual's sensitivity (in this case, towards the rumor's topic)[21].

The fact that this principle has been known for a long time, even before its scientific formulation is demonstrated by Aesop's fable, when the repetition of the screams of the liar shepherd announcing the wolf attack ended up rendering the sign devoid of informative quality. The soundness of this principle acquires a new magnitude in the light of its mathematical formulation:

$$H = - (p_1 \log_2 p_1 + p_2 \log_2 p + ... + p_n \log_2 p_n)$$

4.3 Feedback

Feedback means a communication network producing action in response to incoming information, and includes the results of its own action in the new information through which it modifies its later behavior[22].

In effect, according to the Information Theory, through feedback the sender receives the return information from the recipient, incorporates it to its own behavior, and modifies its message in accordance to this behavior. However, for social psychology, this definition is limited, since feedback has a broader meaning: it is a progressive identification with the interlocutor and an enriching personal exchange with him; this is the ideal principle of the understanding process[23].

Feedback plays a major role in the Theory of Rumor. When a rumor is spread, it is likely to be heard more than once in a single network and to be passed on to the same person more than once. In this situation, the possibility of this message to be augmented, modified or exaggerated (to obtain additional attention) is increased. A participant not only tells the original story but he modifies it to turn it more sensational or to find another perspective[24].

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[21] Didier Anzieu and Jacques-Yves Martin, *Dynamics of Small Groups*. (In Spanish: Buenos Aires, Editorial Kapelusz. 1980).

[22] Wolfgang Koehler, *Gestalt Psychology: An introduction to New Concepts in Modern Psychology*. (New York, Liveright Publishing Corp. 1947).

[23] Karl W. Deutsch, *The Government Nerves. Communication Models and Political Controls* (IN Spanish: Buenos Aires, Editorial Paidós, 1993).

[24] According to Feigenbaum "a series of ever increasing self-reinforcing errors carries an organized system over the edge of order into a phase transition and on to chaos." (Koehler, Gus: "Fractals and Path-Dependent Processes: A Theoretical Approach for Characterizing Emergency Medical Responses to Major Disasters". In: Robertson, Robin y Combs, Allan (edit.): *Chaos Theory in*

Many theorists have pointed out that transmitters are not involved; their objectives is to transmit, as reliably as possible, what they have heard from the previous transmitter regarding a message not connected with ego. The information flow is unidirectional and non-interactive. A speaks to B who in turn speaks with C, and so on. In real life, there are, however, loops in the process. D can call A to warn him against a rumor. In addition, rumor transmission is not a simple flow; B does not only pass a message to C. Communication is truly interactive. In real life, C asks questions to B and they both create a message. Each can add his own details to the rumor, a process that leads to the snowball effect, instead of the leveling process described by Allport and Postman in Chapter 1 [25].

When feedback is positive the transmission system reaches great dynamics and in successive bifurcations it can enter a chaotic state. Conversely, when it is negative, diffusion tends to reduce up to a point of equilibrium where rumor does not spread and dies. An example of the first case is TWA Flight 800 (see Chapter 2), where successive different versions (the friendly missile, the enemy missile, the bomb, the flawed gate, the UFO, etc. theories) followed one another during all the period of uncertainty.

Negative feedback can obey different reasons, e.g. lack of credibility, both in the transmitter or the alleged source of the rumor or the content itself (see Chapter 1). But it can also derive from the message's unintelligibility. Gubern says that the problem is the breaking point produced when the increase of information derived from the message's newness is rendered null due to its social unintelligibility; then information level drops to zero and thus the message becomes noise[26].

The mathematical model of this phenomenon, with **n** as the variable that measures the message's progressive newness is expressed as follows:

$$\mathbf{H = f(n)}$$

H is the amount of information and **n** can be replaced by the increasing statistical singularity of the message's articulations measured in terms of improbability **(-log p)**, but as from the critical moment, which is to be empirically determined in each communicational experience, when improbability is so high that the graphic curve of Cartesian axis declines to zero (mutation from increasing function to decreasing function).

According to Gubern, this dialectic between originality and intelligibility highlights the practical importance of the so-called originality density of a message (by time unit or surface unit). This density is not to exceed the critical maximum of human aptitudes, whose ceiling has been empirically assessed at 16 bits per second, establishing the intelligibility limit[27].

Psychology and the Life Sciences. Lawrence Erlbaum Associates, Publishers, New Jersey, 1995. Page 202).

[25] G.W. Allport and Leo Postman, *The Psychology of Rumor* (Buenos Aires, Editorial Psique, 1988) .

[26] Román Gubern, *op. cit.*

[27] Román Gubern, *op. cit.*

4.4 Rumor as Emerging Phenomenon of Social Perturbation

The shape and evolution of societies is sometimes determined by the environment where they are immersed and interact with. Within this framework, communication is the sum of all exchange mechanisms used by individuals from societies to express their needs, emotions, or other outer messages; it also permits coordination, the adhesive that gives society cohesion.
Societies evidence increasing global or added complexity as the individuals who compose it and the communication channels they use are more complex. In this context, and under certain special circumstances of high tension and uncertainty, rumor appears as an emerging phenomenon out of individuals' interaction, determined by collective action rather than by individual's initiative.

It is worth knowing the structure of social agents and their interaction rules because they determine the emerging collective behavior. What is especially interesting in rumor as social emergent is the individuals' interactions that are responsible for general situations at the micro-level (e.g. governors); they possess a high level of communicational entropy, observed on the macro-level in a fractal scale. When this occurs, the entire population acquires emerging properties. Each individual is attracted to the state and the collective effect produces emerging properties. If under these circumstances a strange attractor governs social dynamics, the resulting behavior can be an edge of chaos or chaotic state.

New ideas -specially if insufficiently communicated (lack of redundancy) or badly communicated (cognitive dissonance)- normally disturb a population, feed people's minds, and generate new behaviors connected in feedback loops. Thus, the social system in non-equilibrium condition, sways away from its still position and exhibits dynamical behavior.
In general, a complex system can have several operating dynamical modes (think of a group of blue-collars in a factory about to close down and what they can do during a demonstration). We would expect a combination of regular and surprising changes: for example a chant starts suddenly and continues until a perturbation (the police siren or a stone thrown to a window) modifies the state (to one of greater uncertainty); the crowd remains still until a new perturbation (violent repression) takes place and the "demonstration" system state changes once again (some panic-stricken participants run and others confront police repression).
Any system under strain can experiment rapid changes of state. One of the most frequent is related to quakes. It has been found that quake activity results from a force- distribution law. The seriousness of a quake is related to frequency by an inversely exponential formula. In every period, lower quakes occur before stronger ones. This escalating relation is also relevant in the example considered here. The rumor of the closing down of a plant runs as wildfire among the factory's population: from small groups first, to departments until it reaches the public opinion through formal channels (press). It cannot be stated that a major perturbation will have a major effect, and that a minor perturbation will have a minor effect. What is unbelievable is that the effect of any system's perturbation can damage the strong causality principle and range from zero to infinite, with inherent unpredictability.

4.5 Rumor Diffusion Analysis

4.5.1 Interpersonal Transmission Networks

Not all rumor is word of mouth, i.e. interpersonal communication, but a large amount of it is, and oral communication in general has special characteristics relevant to rumors. The disposition of rumor participants, as well as interpersonal patterns of communication, are also factors in oral communication transmission. Therefore, word-of-mouth communication has a strong impact and it is convincing.

The reasons for the efficacy of face-to-face communications have been summarized by Charles Wright[28]:

1. Personal contacts are more casual, apparently less purposive, and more difficult to avoid than mass communications. Many people are highly selective of mass communications, avoiding materials that go against their personal opinions or that hold no interest for them. But people are less likely to anticipate the content of a personal communication or to take steps to avoid it.
2. Face-to-face communication permits greater flexibility in content. If the communicator meets resistance from his interlocutor, he can change his line of argument to adjust to their reactions.
3. The direct personal relationships involved in face-to-face communication can enhance the rewards for accepting the message or argument and the punishment for not.
4. Many people are more likely to trust the judgement and viewpoint of persons whom they know and respect than that of an impersonal mass communicator.
5. By personal contact the communicator can sometimes achieve his purpose without actually persuading the interlocutor to accept his point of view.

The characteristics of person-to-person communication in general are relevant to hearsay when it is transmitted in this fashion. However, the nature of the rumor message is specialized in that it is sensational and offbeat and is subject to various responses by the recipient. In the rumor process, the orientation of the person involved may vary. H. Taylor Buckner describes what he calls "sets" that a person may have[29]. A "critical" set is one in which the hearer has the background and motivation to evaluate the message critically and repeat or not repeat it on the basis of his informed decision. An "uncritical" set involves an individual who lacks critical ability and cannot and/or will not evaluate the message objectively and therefore simply passes it on in one version or another.

The third condition, in which a person hears a message and passes it on because he is told so, is called a "transmission" set. The transmitter is neither critical nor uncritical, but neutral.

The set most often found is the uncritical one. Buckner says that "certain circumstances or emotions hamper or dominate the possibility of exercising critical ability ... if believing a rumor fills a need of the individual, he will be much less likely to reject the rumor.[30]"

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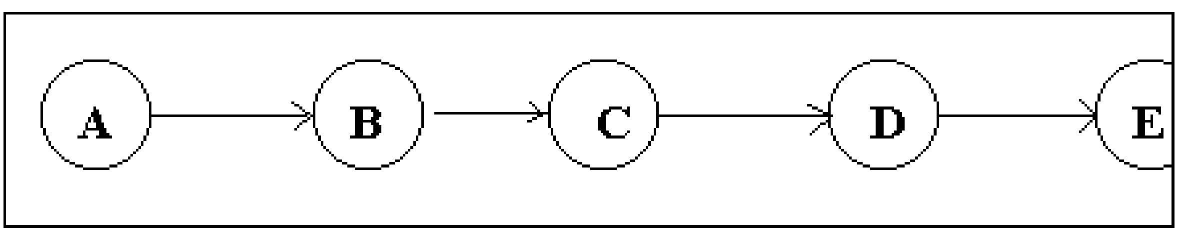
[28] Charles R. Wright, *Mass Communication* (New York, Random House, 1963).

[29] H. Taylor Buckner, "A Theory of Rumor Transmission", *Public Opinion Quarterly* (Vol.1 Nº 29, Chicago, 1965), Pages 54-70.

[30] H. Taylor Buckner, *op. cit.*

As mentioned previously, the pattern of communication into which a message falls as it is passed from one person to another may vary. Both the disposition of the participant and the pattern of communication can combine to affect the course traveled by a bit of information.

Of all the structural models of rumor communication, the most universally known is the one developed by Allport and Postman[31].
Who does not recall having participated or witnessed a game called “Telephone - A Wrong Number”(something like Chinese whispers) where a person transmits a message to the first participant, who whispers to the next who in turn passes it on to the third, and so on. Finally, the last one repeats the last version of the message aloud, after which the anchor person repeats the original message. At the end of the game the group discovers the aim of the practice: transmission distorts messages.
“Telephone” and its variants, however, are actually of limited value as a rumor experiment. Rumors involve many more people than this demonstration implies, and they do not necessarily travel in a chain sequence. Rumor participants are highly motivated in transmitting and listening to the message; there is no “static” misperception that goes along with whispering in the ear.
The “telephone” message content itself is usually nothing of any particular interest, and thus there is no intrinsic motivation to pass it accurately from one person to another. The only motivation is the “transmission set”, which merely entails going along with the instruction given by the leader. In a typical “telephone” situation there is no attempt to modify, to shape, or to be flexible. There is no feedback; the recipient does not ask questions or re-request elaboration or any kind of clarification. There are minimal -if any- facial cues, body gestures, or paralinguistic cues that can be used to emphasize the content of the message or to ascertain the receptivity of the hearer. Nor is there a rewarding experience to be gained from sharing in the message. In addition to the fact that the “telephone” message is not interesting, it is not supportive of mutual values and does not inspire gratification for accepting and passing it on to someone else. The structural nature of the “telephone” message assumes a simple linear pattern in message communication.



Linear transmission or “telephone”’ transmission

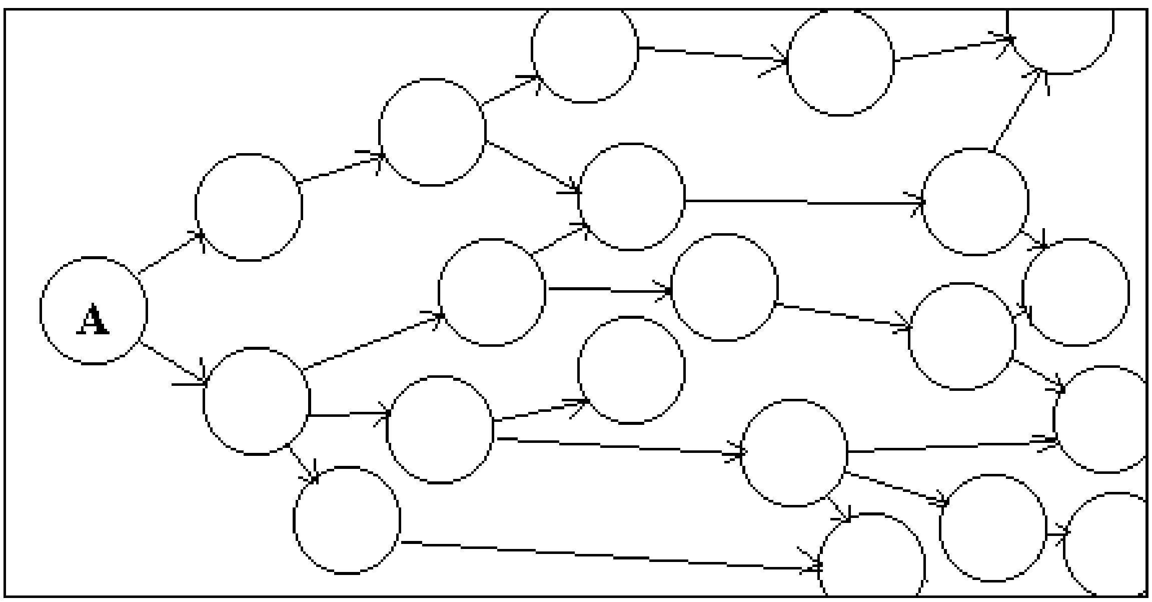
Not only is it linear but transitive, because A says something to B, B says something to C, and so forth. (“Transitive” here refers to the property of being passed on successively from member to member in a single non-reversible direction.) Rumors, on the contrary, very seldom travel in a direct line, although they sometimes may be transitive. If they followed a chain structure, any person along the line who was not interested in the rumor, who did not believe it, or who was critical or resistant in any way would, as they say, “dead end” it immediately. The rumor would be stopped. The probability of someone along the line

[31] G.W. Allport and Leo Postman, *op. cit.*

being of this frame of mind is very high. The survival capacity of rumors, then, would be quite limited if the linear model were appropriate in describing them[32].

4.5.2 The Dissipative Model

Rumors, in fact, persist even though they are passed along in the basic form of telling and hearing. They spread rapidly and widely because they diffuse not in a linear, chain fashion but in a branching pattern. The following figure is based on the premise that if a message is interesting enough, it will be passed on to two or more people. Each person in turn will tell it to two or more people, and the message will fan out. No single person, no matter how unmotivated or critical, will stop it, as would happen in the chain model. The branching model still entails the left-right transitive, hearer-teller-hearer sequence. By branching, however, it reaches many more people in a short period of time and spreads rapidly.



Branching or dissipative transmission

Messages following this communication pattern are very difficult to stop. They pass through collections of people as an aggregate, even though these people do not have the interpersonal relations necessary to form a social structure. And even if there is any structure, it is of little importance in this pattern of rumor. From what we know from past rumors that follow this branching model, it seems that they are usually very dramatic, sensational rumors that are of general interest to everybody. People in a rumor network are highly motivated, sensitized to receive and pass on this message. Circumstances of this type usually involve "crisis situations", where people are afraid or confused and eager to find out what is going on. In this state they welcome any sort of message that provides

[32] Fredrick Koenig, *Rumor in the Marketplace: The Social Psychology of Commercial Hearsay* (London, Auburn House Publishing Company, 1985), Page 109.

structure or meaning to events or that reinforces their heightened feelings. Such rumors are typical during race riots, natural catastrophes, and wartime emergencies, and they can sweep through a population like a firestorm[33].

One of the early assumptions about mass media communication was that a transmission from a source would spread out indiscriminately through an aggregate of people. The "spray" metaphor through which the publisher would "spray out" information and anyone who was in the path would get wet was shared by supporters of this position. Lazarsfeld[34] set up the study to see how "wet" the electorate would get. He studied the communication in an election campaign as it progressed, in order to see how it affected people's attitude, and ultimately, their voting behavior. In brief, he found that the campaign itself did very little to change people's orientations, candidate preference, or voting behavior, but he did come up with other findings. One was that people tend to select the aspects of a campaign that support their original positions. Thus, the information was used not for any kind of orientation, reorientation, or education but more for support of existing opinions.

Of even more interest to the purpose here was the finding that he could predict how a person was going to vote more by knowing the group the person belonged to than by evaluating his behavior regarding the campaign appeals. The consensus of the group to which the person belonged -not how many talks, speeches, or campaign messages the person listened to- seemed to dictate how one was going to vote and to form one's opinions about the elections. In addition, Lazarfeld found that in every group there was a person who seemed to be an opinion leader. This person was more active in the campaign in terms of reading and listening and keeping informed. He was the one asked most often what he thought about the campaign as it progressed and was also the one who offered more of his own opinion to members. Such opinion leaders were termed "influential" in subsequent studies.

Lazarfeld concluded from his research that the process of communication in an election campaign does not fit the model of a communication source spreading out and "spraying" a mass audience. Rather, a mass audience has a structure and communication progresses in what he called a "two-step flow": from the media source to the opinion-leader, and from the opinion-leader to the group. This model is certainly a simplified one, but it points out the importance of group membership and group structure in the communication and feedback processes. Later studies confirmed this process of opinion-leaders and their influence, although it was subsequently discovered that there is not a single opinion-leader in a group but several, based on "specialties". Thus, in a given group, there may be an opinion-leader in politics, another in marketing, and so forth. Nevertheless, the structure of the group remains essentially that of the original model of the two-step flow, where the influential members pass information on to members of the group. The structure of group membership (who belongs to the group and who has prestige, power, and influence) will greatly influence how information is transmitted.

Degh and Vazsonyi have emphasized two essential characteristics related to rumor transmission: recipients are selected and each of them is free to send a message again or not. Re-senders are self-appointed. Observing information flows at prison camps in World War II led to the observation that, despite the boredom that made everyone anxious to

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[33] Fredrick Koenig, *op. cit.*, Pages 109-110.

[34] Paul Lazarfeld, Bernard Berelson and Hazel Gaudet, *The People's Choice* (New York, Columbia University Press, 1944).

receive any type of information, such information was not transmitted indistinctly. For example, A selected receptors D and E instead of B or C. In addition, no all recipients sent messages again (D did, E did not). Degh and Vazsonyi termed this “rumor channel”[35] to refer to the contact established among individuals qualifying as recipients or transmitters. In a specific group, a rumor is transmitted by members of a rumor channel. According to these authors, “jokes are transmitted through the joke channel by a sequence of witty people; riddles or enigmas go through the riddle channel constituted by riddle-fans, etc.” It is not the same individuals who transmit everything: “people fond of ghost stories are not necessarily the same people who enjoy jokes.” Story-tellers learn their stories from similar personalities and pass them on to selected peers.

A rumor is not heard by chance: senders often select those who they will speak to and they avoid those who may possibly refute the rumor. This selection is of utmost importance for gossip. Since gossip targets other people of the same community (town, office, club, etc.) alliances are vital. However, in critical situations, social barriers fall apart and everyone speaks with everyone. It is well known that a few minutes after President Kennedy’s murder, people started to speak about it in the street. In real life, unlike what has been said about chain transmission according to experiments, a person may well pass on a rumor to more than one recipient; therefore, retailers and hairdressers are known to be real media sources. They are at the crossroads of numerous communication networks.

Jakob Moreno, a psychiatrist cited by Koenig[36], published some findings that are compatible with the structural analysis of communication. In institutions for “delinquent girls” he used questionnaires to identify interpersonal preferences about who was attracted to whom as friends. He called this attraction patterns “sociometric diagrams” and the technique “sociometry”. Sociometric analysis has since become an important technique in many types of social science research. Essentially, it asks people to indicate whom, for example, they would choose to work with on a task, whom they would prefer to do something with in a designated activity, or whom they would choose as a roommate (see its application in Schachter and Burdick[37], chapter 2).

These choice patterns, as they are set up, indicate who belongs to what group or clique, who is the most popular, who seems to be the most attractive, and who is the most influential.

It would seem reasonable to suppose that rumor transmission could be very well related to the membership and structure of such groups. In fact, Moreno discusses the relationship between interpersonal friendship patterns, the sociometric diagrams, and -among other things- the passage of rumors. He tells how the sociometric diagrams provide a description of the communication networks through which rumors and gossip passed in these training schools.

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[35] L. Degh and A. Vazsonyi, “The Hypothesis of Multi- Conduit Transmission in Folklore”, Cited by Jean-Noël Kapferer, *Rumors: Uses, Interpretations & Images* (New Brunswick and London, Transaction Publishers, 1990), Pages 60-61.

[36] Jakob Moreno, *Who Shall Survive?* (Washington D.C., Nervous and Mental Disease Publishing Co., 1934), Cited by Fredrick Koenig, *op. cit.*, Page 114.

[37] Stanley Schachter and Harvey Burdick, “A Field Experiment on Rumor Transmission and Distortion”. In Alfred G. Smith, *Comunicación y Cultura (2).* (Buenos Aires, Ediciones Nova Visión. 1977 in Spanish), page 203-220

An example of a sociometric analysis applied specifically to the diffusion of rumor is the study reported in 1979 by sociologist Gary Fine[38], who has done much research on folklore in general, and rumors in particular. Fine reports a study in Southern Minnesota regarding the diffusion of rumor among pre-adolescents. He did an analysis of group membership structure with sociometric techniques and demonstrated how the rumor was transmitted through groups such as school classes and athletic teams. A given story would circulate among members of a baseball team or a softball team, and sometimes among friends who attended the same school and were in the same grade.

One of the structural findings in Fine’s research confirms an earlier observation that “isolates” (unpopular or least popular members of a group) often are the ones motivated to initiate the transmission of a sensational type of story such as rumors. In one sociometric network the rumor was first told by a member named Ronald. The sociometric choice patterns of this group showed that Ronald was a member that no one chose as friend, making him an isolate. Similarly, in the transmission of the Satanism rumors, there seemed to be a tendency for the lower-status ministers to be the ones to initiate rumors within the religious network. According to Koenig[39], these ministers in fundamentalist circles are classified as “weak brothers” as opposed to “strong brothers”. They are not the ones who have charisma, not the ones who go out and proselytize and attract big crowds. In general, they are gray individuals without a bright personality sent to maintain and administer church organizations after the latter have been established.

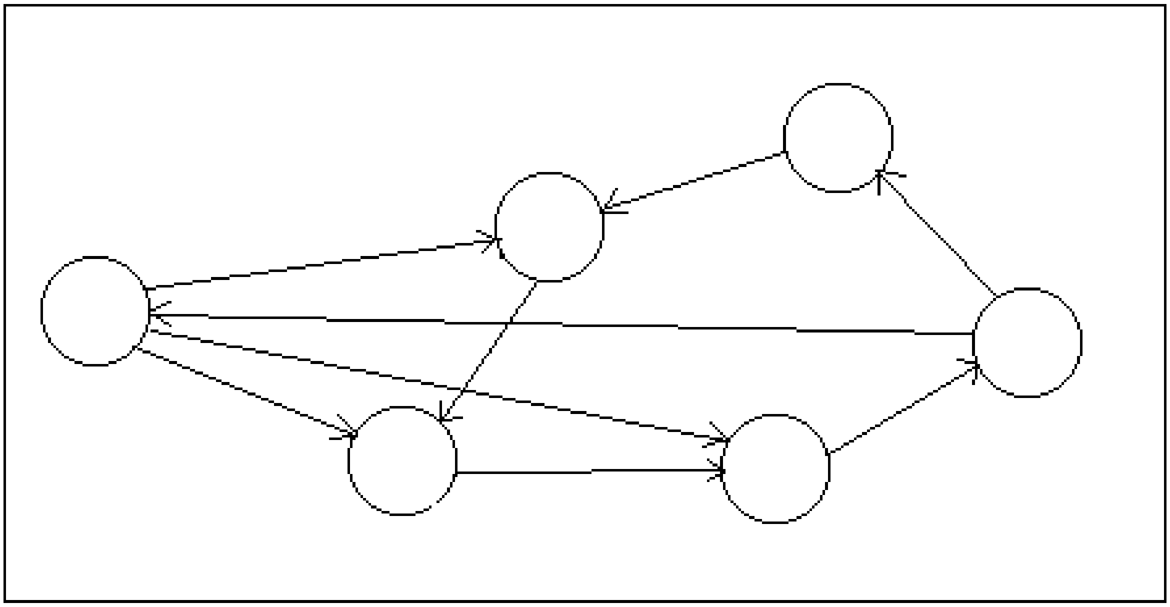
Because rumor-passing is, among other things, an attention-getting device, isolates are more motivated to tell sensational stories just for the notoriety they confer. This situation is structurally opposite in direction from the two-step flow, in which high-prestige, influential opinion-leaders transmit information to the group. As to “isolates”, the diffusion process seems to be initiated by the isolate; it starts at the bottom and moves up through the low-prestige ranks to the top. Then the story is transmitted by the opinion-leaders to the prestigious members of a group. According to Fine, when members of the clique were interviewed, they had forgotten -or simply did not acknowledge- Ronald, the isolate, as part of the group and part of the rumor transmission process.

This pattern is an interesting twist on conventional network theory. In the traditional studies, the “influentials” have prestige and specialized “expertise” in certain areas of knowledge; in the case of rumors, the “influential” specializes in “contraband”, non-verified information.

Rumors that are introduced into a group of interpersonal relations often exhibit the patterns of a network. Interpersonal networks involve multiple interactions in which the message is sent to several people in the group, is repeated and sent around again. As it is sent and received from several sources with negative and positive feedback processes, various complicated patterns can result. A given individual can not only pass messages to more than one person but can also receive them from more than one person. The following exhibit illustrates rumor transmission of this network type.

[38] Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976).

[39] Fredrick Koenig, *op. cit,* Pages 39- 72.



Rumor communication in an interpersonal network.

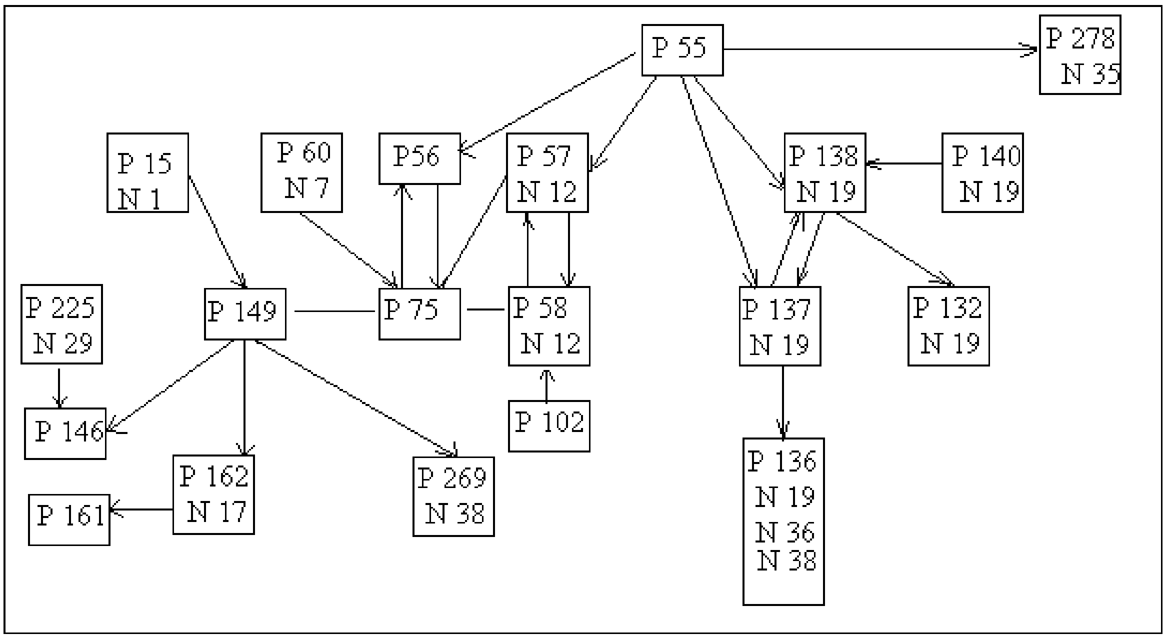
H. Taylor Buckner has examined the nature of rumor transmission through what he calls "multiple interaction networks"[40]. He indicated the combination of effects by taking into account disposition as well as structure and as we mentioned earlier, he also established several categories which he calls sets, the "uncritical" set being the one into which most consumer rumors fall. The participant has very little information by which to evaluate the rumor as to its truth or falsity, but he passes it on to one or more individuals. He may speculate with the person with whom he is interacting as to the nature of the information, but he has very little of what is known as "objective reality testing". He may have reasons for wanting to accept the content of the rumor.

When product rumors and uncritical sets are involved with the multiple interaction network, the information being passed through has special qualities that will affect the nature of the message. As we have said repeatedly in Chapter 1, a rumor must be passed on, must attract interest and attention, and must be sensational in order to survive. A rumor is to be heard more than once in a network and to be passed on to the same person more than once. In such an instance, the possibility of the same message being augmented and exaggerated (to get additional attention) is increased: a participant not only tells the original story buy modifies it to make it more sensational. The elaboration of the message serves the function of keeping the teller an active participant in the rumor process. Professor Buckner states: "The rumor will pick up new details in a dialectical process, synthesizing new rumors with new meanings, each of which may be modified to produce a better story or a better Gestalt. The more times the individual interacts, the greater will be the production of a false, distorted, and bizarre rumor, and in this situation the rumor will snowball[41]." This is what Shibutani refers to as "ideas whose promotion and feedback is a

[40] H. Taylor Buckner, *op. cit.*

[41] H. Taylor Buckner, *op. cit.*

give and take[42]", and is the reverse of Allport and Postman's leveling and sharpening, which may work when you have the rare occurrence of a linear chain pattern[43].
In network transmissions that involve redundancy, repetition and feedback, however, one tends to be motivated toward elaboration of the story. If there is adding on and embellishing to provide interest, the result will be the opposite of leveling and sharpening.
Individuals can, of course, belong to more than one network, which makes the process even more complicated.



Multiple interaction networks. P is the individual's identification number., and N is the networks identification number.

Buckner did a secondary analysis of information diffusion in the state of Washington. An airplane was sent over a town to drop leaflets bearing slogans, which were to be completed from information gathered from other members of the community. The reward was five pounds of coffee for anyone turning in the completed slogans to a designated address.

The point of the study was to identify the information diffusion patterns in the community. Buckner also wanted to find out the parameters of the multiple interaction networks. He identified forty-two rumor networks, one of which is represented in the figure above. As can be seen, many people belong to more than one network.
According to Buckner's conclusions, message diffusion usually takes on a branching form when it travels between groups. Sometimes this diffusion from group to group occurs through mass media and sometimes through a combination of interpersonal networks and mass media[44].

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[42] Tamotsu Shibutani, *Improvised News, A Sociological Study of Rumor* (Indianapolis- New York, The Bobbs-Merrill Co Inc, 1966).

[43] G.W. Allport and Leo Postman, *op. cit.*

[44] H. Taylor Buckner, *op. cit.*

4.5.3 Transmission Models through Cellular Automata

During World War I, German psychologists followed two trends: one went towards deconstructing the person and the situation into elements in the attempt to explain behavior in function of simple causal relations. The other trend tried to explain behavior as a function of factor groups that constituted a dynamical whole: the psychological field, i.e. the person itself and his surrounding environment just as he sees it. The problem is no longer perceived as a matter of relations between isolated elements but in function of the dynamical interplay of all the factors involved in the situation.

It was by then that Kurt Lewin[45] started to formulate a method to analyze psychological situations based on mathematical re-formulations: geometry to express the relations of position of the parts forming the vital space, and vectors to express strength, direction and point of application of psychological forces. The use of geometry was natural for a psychological approach that insisted in a world "such as it is viewed by the individual himself", since human beings tend to represent themselves in the contextual field as if there was a "space" around them. The geometrical approach also offered a convenient medium for the diagram representation of many psychological situations.

After some time, and based on the work of Lewin[46], Alex Bavelas[47], Josephine Klein[48], Anzieu and Martin[49] and others, while analyzing group dynamics and their cooperation, developed several variants for data diffusion by describing the life processes of a group; their members were considered automata and identical to make communication networks structural analysis easier.
Bavelas develops the concept of standard and communication with the deliberate purpose of applying them to psychological situations – basically analysis of cooperation in small groups- but he does not intend to establish a rigid link of these ideas and psychological or social situations. He just suggests general scopes within which its application may be fruitful. He states that in the field of social groups there seem to be two outstanding aspects in communication: communication among individuals (or groups), and communication between ideas and attitudes; he also says that rumor diffusion is a good example of these aspects. Rumor diffusion speed, direction, and extension depend on the connection standards between individuals and groups, and on the connection of rumor content with other ideas and attitudes, specially as to rumor growth and distortion and the disposition to hear it and pass it on. To analyze this aspect he develops the concept of interconnected cells (cells stand for agents or individuals) and he models the type and distance of their interconnection network structure. Based on that, he tries to define a

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[45] Alex Bavelas, "A Mathematical Model for Group Structures", in Alfred G. Smith (compilation), *Comunicación y Cultura*. (IN Spanish: Buenos Aires, Ediciones Nova Visión. 1977), Page 91.

[46] Alfred G. Smith (compilation), *op. cit.*

[47] Alfred G. Smith (compilation), *op. cit.*

[48] Josephine Klein, *Group Studies*. (México, Fondo de Cultura Económica. 1975. In Spanish).

[49] Didier Anzieu and Jacques-Yves Martin, *op. cit.*

possible geometry to deal with the psychological space, and to explore the consequences of a specific series of assumptions and definitions in a limited way.

The concept of agents or cells of Bavelas' geometrical model is not to be confused with cellular automata developed mainly by Von Neumann[50] and complemented by Moore. According to Moore, individuals are equally considered cells of a transmission network; in this system the behavior of each cellular units can generally influence their closest neighbors, who in turn influence all the other units they are connected to through various mechanisms.

The basic difference between Bavelas' and Von Neumann's geometrical models is that the latter refers to simple dynamical models that can be "run" in a computer for emerging pattern analysis. In this sense, cellular automata models can represent the rumor diffusion process depending on individuals' change of attitude in function of the attitude of their neighbors (membership group).

Epstein and Axtell[51] developed several models based on cellular automata, e.g. genealogical networks, friendship networks, loan spatial networks, trade exchange networks, and above all, epidemic transmission networks. Brown [52] developed a model of cellular automata to analyze the political dynamics and the behavior of voters in a bipartisan social structure.

Since the bipolarity or binarity of a bi-partisan political party as the one modeled by Brown is also a characteristic of rumor transmission (they are accepted and transmitted or else rejected and their diffusion is inhibited), it would be interesting to adapt Brown's model to this specific case.

It is obvious that rumor diffusion, whether in interpersonal, organization, national or global networks, results from individuals interaction. These individuals are members of their respective membership groups, and in turn they can count with one or more opinion-leaders.

According to Katz and Lazarsfeld[53], and as seen before, individuals' important decisions do not result from the influence of social messages on them but from the opinion of friends regarded as sound and trustworthy, who are the real persuasive targets of messages.

Opinion-leaders, respected for their knowledge and criterion, play a major role in influence groups. This is so because in an important decision the admittedly ignorant and non-decisive addressee seeks a learned friend's or relative's advice; this behavior is shown in relatively important everyday decisions, such as buying a car, investing in real-estate, or taking a medicine prescribed by the doctor[54].

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[50] J. Von Neuman, *Theory of Self-Reproducing Automata* (University of Illinois Press, 1966).

[51] Joshua M. Epstein and Robert Axtell, *Growing Artificial Societies* (Washington D.C., The Brookings Institution, 1996).

[52] Thad A. Brown, *Nonlinear Politics*. In: L. Douglas Kiel y Euel Elliott, *Chaos Theory in the Social Sciences. Foundations and Applications*. (The University of Michigan Press, 1991). Page 127.

[53] E. Katz and P. Lazarfeld, *Personal Influence: the Part played by People in the Flow of Mass Communications* (New York, Free Press, 1955).

[54] Román Gubern, *op. cit.*

Leaders base their opinions in interactions with their advisors who form impressions of them. Relations change as such impressions and experiences record subsequent interactions. What opinion-leaders say and do influences the rest of the group. The process is reflected on the individual level that decides, for example, to support a rumor on the basis of interactions with friends, family, or acquaintances in the local scope.

A useful event that illustrates the impact of social dynamics might be the black Monday: October 19, 1987. Brock[55] interprets the market collapse that took place on that day in the main stock markets in the world as being the product of a herd behavior induced by the attenuation of normal information channels available to traders, which is precisely the source of rumor generation. His parable goes as follows: in a market functioning normally, traders regularly upgrade their information by calling on industry and security analysts. Communication between the traders and industry analysts is open. Prices are a function of both past price performance and volume, as well as expectations for future earnings and dividends. When a negative shock hit the market, prices drop. Traders use the behavior of other traders, price, and information from analysts to decide their next move. If the negative shock is large enough, the information channels between traders and analysts jam due to many phone calls. A trader is left with simply following the herd; the only existing information is the movement of prices and the observed behavior of other traders and the rumor wave. As Brock suggests, a sell-off gets started when a positive feedback loop emerges in an otherwise insipid market.

Banerjee[56] further argues that herd behavior can occur where a decision-maker pays relatively more heed to information others perceive to have. The reason is simple: the visible actions of others may be based on information that the decision-maker lacks. Information is replaced by the rumor and by other signs from the rest of the stock operators and the herd takes off. The event of an economic landslide suggests even catastrophic change, let alone small shifts in preference, can result from group interactive effects.

Individuals can reflect and follow for some time the beliefs of others, because the signs that they decode fit within a variety of classical social psychological perspectives that suggest that individuals who are adapted to the social environment[57] form impressions about others based on behavioral experiences[58]. Decision-makers modify their own behavior and the influence of the social environment through self-selection, avoidance, migration, or a generalized contagion process.

Social dynamics and the concomitant social behavior cannot be reduced to individual behavior in the sense that isolated individuals cannot induce the variety and richness of global collective behavior prevalent in any social system. Social behavior is by definition holistic and synergetic and must be the product of interacting individuals who can communicate and modify their behavior as a consequence of their interactions. It is an emergent from the Complexity Theory’s perspective.

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[55] Thad A. Brown, *Nonlinear Politics*. In: L. Douglas Kiel y Euel Elliott, *Chaos Theory in the Social Sciences. Foundations and Applications*. (The University of Michigan Press, 1991). Page 122.

[56] Thad A. Brown, *Nonlinear Politics*. In: L. Douglas Kiel y Euel Elliott, *Chaos Theory in the Social Sciences. Foundations and Applications*. (The University of Michigan Press, 1991). Page 122.

[57] Leon Festinger, *A Theory of Cognitive Dissonance*. (California, Standford University Press.1957).

[58] Fritz Heider, *The Psychology of Interpersonal Relations*. (New York, John Wiley & Sons. 1958)

Cellular automata are dynamical systems with many discrete degrees of freedom. The beauty of automata is that while the rules of interaction are surprisingly simple, complex non-linearity can be induced by the iterative nature of interaction. As non-linear systems, the ones based on cellular automata can display a full order. Cell-space models have been used in physics, chemistry, and biology, and to a more limited degree in the economic and social sciences to investigate the ecological structure of behavior. In the theory of rumor, they represent the potential to "program" individuals' attitude towards a rumor and therefore give us more insight into the diffusion and transmission dynamics.

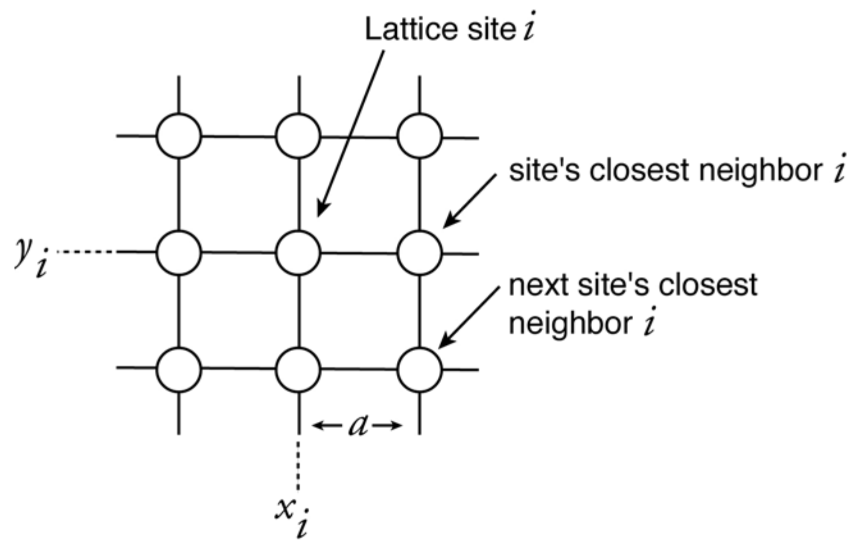
Rules can reflect essential existential states of accepting and rejecting a rumor. Acceptance attracts and induces assimilation; rejection repels and induces egestion. Rules can be deterministic or probabilistic. In both cases, cellular automata are formed on a lattice.

Cellular automata clearly produce patterns in space and time that can be moving fractal clusters if the underlying dynamics are chaotic. We can determine if the underlying dynamics are chaotic by watching the spread of small changes in the configuration of the system on a lattice.
A lattice is usually a **d**-dimensional array of discrete cells whose behavior is governed by local, uniform, and time-independent rules. Boundary conditions may be periodic. The rules determine the behavior of individual cells (people) as they interact with others at the next time step. Future states of a cell are normally a function of the values of neighboring cells and the cell itself. The radius of a cellular automata is the number of neighbors whose state at time **t** affects the state of any cell at **t +1**. The state of a cell is a variable, $\mathbf{s_i}$ (where $\mathbf{i = 1,2,..., N}$), which can be any measurable trait. If $\mathbf{s_i = 0}$ we can say the individual rejects the rumor; if $\mathbf{s_i = 1}$, the person accepts it. The state of the entire system, its configuration, is defined by the collection of values ($\mathbf{s_1}$, $\mathbf{s_2}$...., $\mathbf{s_N}$). From these values, the average fraction of individuals at any time step, $\mathbf{t}$, f_p, **(t)** = $((1/N) \sum_i s_1)$, its variance, and so on, can be easily calculated, as well as the asymptotic fraction of individuals based on a long **a** period. Although individuals remain in fixed physical locations, their willingness to accept and spread the rumor, i.e. their attitude towards rumor may change as a result of interactions with other individuals on the lattice.

By using rules on a lattice, enough interactions between decision-makers can replicate real situations. Finding useful rules that map different forms of behavior is the key to making automata theory viable for the social sciences.
A simple two-dimensional interaction law in which each individual interacts in the same way with its neighbors is the deterministic majority-rule law. This law makes each site adopt the value prevailing among the cell and its four nearest neighbors on the lattice. The interaction rule for such behavior is:

$$G_i(s_i(t+1), \ldots, s_N(t+1)) = \begin{cases} 1 & \text{if} \\ 0 & \text{else} \end{cases} \sum_{|i-j| \leq a} s_j(t) \geq 3,$$

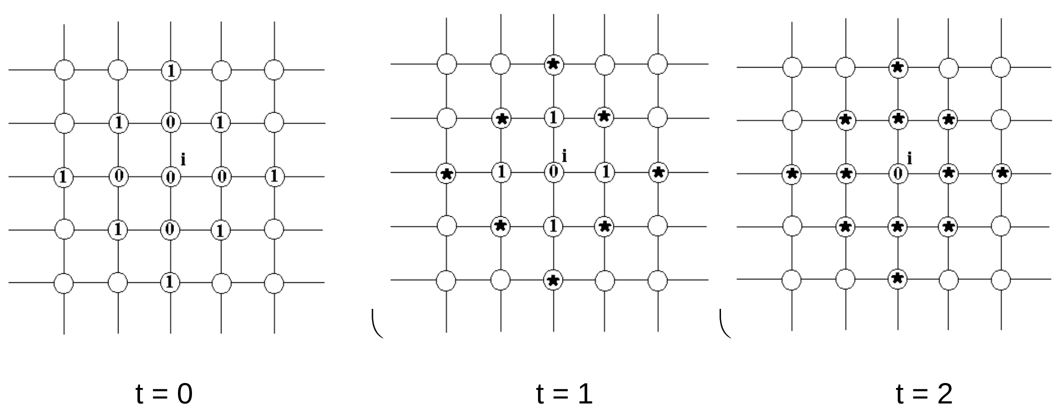
where G_i are given functions of time t and the current values $\mathbf{s_1}$ **(t), ...,**$\mathbf{s_N}$ **(t);**
$|i - j| = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2}$ is the Euclidean distance between cells **i** and **j**, with location (x_i, y_i) **and** (x_j, y_j), respectively. The summation is over all cells j whose distance from i is less than or equal to a, including s_i and its four nearest neighbors as shown in the figure below:



*A representative lattice site, **i**, and its neighbors on a square lattice with D = 2 and lattice constant a. (The coordinates x_i,and y_i designate the physical location of site **i**).*

Thus, individual at cell i rejects the rumor in time **t +1** if, among i and its four nearest neighbors, at least three reject the rumor at time **t**; otherwise, he will accept and pass it on. Since the summation condition always examines five cells, no ties can occur and the interaction law is symmetrical with respect to the influence of those who accept or reject the rumor.

To see how the rule works, consider **i**, starting from some given initial state, **0** (reject), its four nearest neighbors and their respective nearest neighbors, over two time periods, as show in the following figure:



*First two steps of the time evolution of a restricted segment of the lattice, centered at some site **i**, under the deterministic majority law. The values in the circles display the bipolarity (accept- reject) of the different sites; the symbol * means that the state cannot be updated without additional knowledge of the initial configuration beyond what is shown for **t = 0**.*

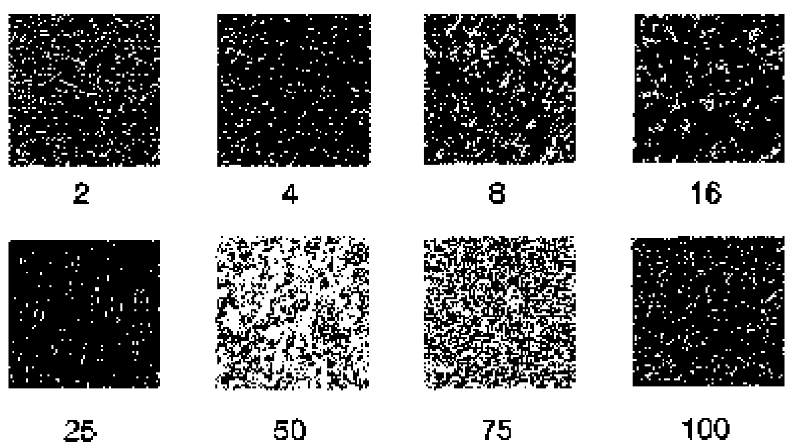
In the first time step, the interaction of the four neighbors of **i** with the peripheral cells leads to a conversion of the four neighbors into rejection, and **i** is the recipient-transmitter. In the second time step, the central cell **i** will also reject the rumor. As shown in the illustration above, over a certain period the individual is affected by others outside the range of the

defined radius of the interaction law. Had we chosen the individual to the Northwest of **i** to reject the rumor instead of accepting it at **t = 0**, then **i** would have kept rejecting it at **t = 2**.
A more general statement would be that the state $\mathbf{s_i(t)}$ will be influenced by the initial states $\mathbf{s_j(0)}$ of all cells j for which the inequalities

$$\left| y_j - y_i + (x_j - x_i) \right| \le ta$$
$$\left| y_i + (x_j - x_i) \right| \le ta$$

hold **(t = 0,1,2,...)**. Despite the simplicity of this interaction rule and its explicitly local nature, it shows that the long-time behavior of the individual depends on the initial configuration of the whole system. A more complicated rule, or one with global characteristics, would not be that sensitive, according to Brown.

Most starting configurations lead the model either to “freeze” into a fixed configuration, or else to cycle with short periodicity. High connectivity (“hot” models) means that configurations are continually altered, so large-scale patterns have no chance to emerge. Models for which the state space has near-critical connectivity are the most likely to produce “interesting” patterns[59].



Changes in system configuration that accompany the transition from “cool” to “hot” cellular automata. Each cellular automata starts from a random configuration and includes more rules (selected at random) than the one before it. The numbers below each image indicate the approximate percentage of configurations related to the model changes.

[59] Brown has applied the cellular automata models to a context of a political voting situation in a bipartisan system such as the USA democracy. He established a bi-dimensional model in 128 x 128 matrixes with a random initial distribution. “ From such stochastic rules it is known that highly ordered systems evolve from what are essentially random configurations, though the specific evolved configurations are themselves apparently random and are highly sensitive to initial conditions. When a stochastic voting rule is applied to a random initial configuration, the system behaves in a fashion that is completely dependent on the initial concentration of Democrats or Republicans. Small chance events early in the history of a political system (or a nested subsystem) may fundamentally alter the numerical power balance between or among political actors.”
Brown, Thad A.: Nonlinear Politics. In: Kiel, L. Douglas and Elliott, Euel: *Chaos Theory in the Social Sciences. Foundations and Applications*. (The University of Michigan Press, 1991. Page 127).

In systems for which a network of finite state automata is a valid representation, the system's behavior will ultimately reduce either to fixed states or else to limit cycles. One such case is the class of genetic nets studied by Kauffman[60]. In his model, genes act as binary switches -they may be active ("on") or inactive ("off")- that not only code for the production of proteins, but also affect the states of other genes. Development, he argues, is largely controlled by the design of this network of switches. Although the state space for such nets is huge, even for a small number of genes (the nodes), simulations confirm that the periodicity of state cycles is relatively short in most randomly constructed nets. Kauffman suggests that these cycling periods determine the timing of critical events, such as cell division. Moreover, the cycles act as attractors, so ensuring that development produces the same end result (i.e. a working organism) in spite of any disturbances that may disrupt the process.

Brown and McBurnett have used a stochastic version of the above model to simulate multiple political realities[61]. In the model, two opposing groups are arrayed on a 128 x 128 periodic two-dimensional lattice of initially randomly distributed sites. When a stochastic decision rule is applied to a random initial configuration, the system behaves in a fashion that is completely dependent on the initial concentration of individuals who accept or reject the rumor.

The finite time path provides insights into the dynamics of rumor diffusion behavior. Thus, for example, a natural clustering of similar individuals emerges as an outgrowth of the interaction rule. Over time these clusters become a randomly built rumor transmitter landscape. (A time series describing this process is given in the figure below)[62].

As in the predator-prey model, the steady gain of one group comes at the expense of the second. The outcome of which group will dominate, however, is by no means predictable. At any point the fortunes of a leading group can be reversed. An equilibrium is not predictable in advance, in that the trajectory of the individual agent exists within a highly irregular social environment. The time series from these and other experimental data appear to have a fractal dimension, though more experiments are needed to determine if this is true, according to Brown, Pfeifer, and McBurnett[63].

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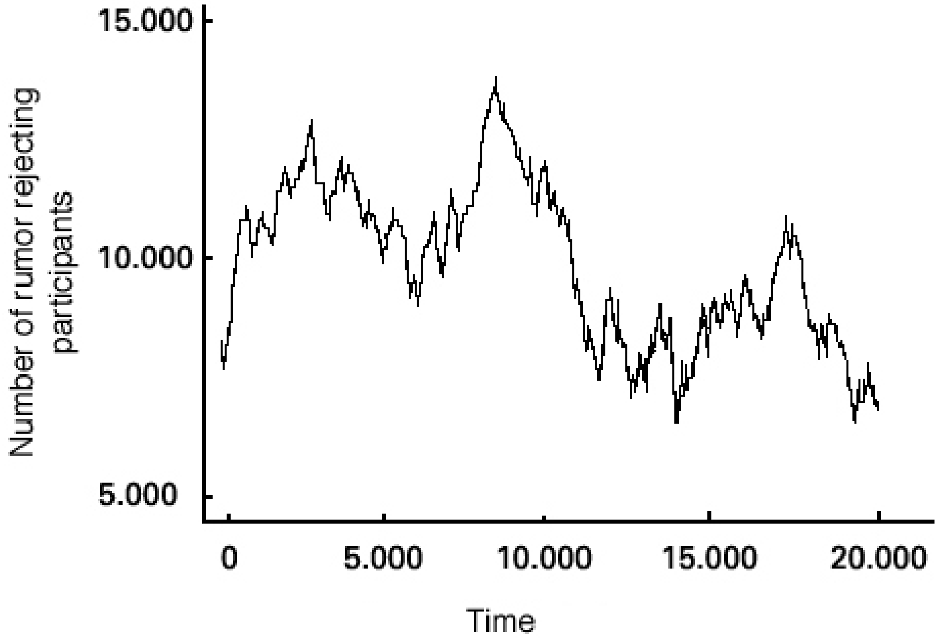
[60] S. A. Kauffman, "Antichaos and Adaptation", *Scientific American* (Nº 265, 2, 1991), Pages 64-70; and S.A. Kauffman, *Origins of Order: Self Organization and Selection in Evolution* (Oxford, Oxford University Press, 1992), Cited in David G. Green, "Emergent Behavior in Biological Systems". En Complex Systems – From Biology to Computation (Amsterdam, IOS Press, 1993).
See http://www.csu.edu.au/complex_systems/green.html

[61] T. Brown y M McBurnett, "Political Life on a Lattice: Emergent Elites and Some Consequences for political Stability, *Proceeding of the ECAL '93, European Conference on Artificial Life* (Brussels, 1992), Cited by Thad A. Brown, *op. cit.* Page 127.

[62] Thad A. Brown, *op. cit.* Page 127.

[63] S. Wolfram, *Theory and Applications of Cellular Automata* (Singapore, World Scientific, 1986), Cited by Thad A. Brown, *op. cit.* Page 128.



Time series of the number of rumor rejecting participants governed by a random decision rule as simulated on a 124 x 124 square lattice with a periodic boundary. Initial conditions are random. Time steps 1 to 20,000 are shown

Wolfram has offered the most complete classification of cellular automata. Cellular automata appear to be classifiable into four general types of behavior: Class I: cellular automata evolve into a fixed, homogeneous state and these structures evolve to fixed limit points; Class II: evolution to a simple periodic structure represented by limit cycles; Class III: chaotic, aperiodic patterns as found when strange attractors are present; Class IV: complex localized organizations as represented by systems that exhibit very long transients with local order and the possibility of an emergent global order[64].

Distinguishable classes of cellular automata related to rumor diffusion can only begin to tell us what the subtle, underlying structure might be. For example, certain types of rumors may represent an example of Class IV behavior by exhibiting very long transients between their generation in the local order and their death in their global order. Class I dynamics, on the other hand, can reflect gossip,, where there exist local scales of order. Class II may be represented, for example, by urban legends, with limit cycle attractors that frequently re-appear.

However, these classifications do not give us greater insight into the rumor reality, the process and order of numerous forms of qualitatively different diffusion systems came about and, more importantly, how they will evolve. For example, if these dynamics are likely to be complex or chaotic, how would we know? On a spatial lattice, for the trajectories to be chaotic, slight perturbations on the initial conditions will have to induce a changed configuration in the values of cells. How two trajectories quickly become different is not the issue because the exact rule of interaction is know. According to Brown, we must instead estimate how rapidly and how far the trajectories will diverge. This suggests that we must first establish the trajectories and find out how close one is to the other. It is necessary to know how many individuals belong to one group or another (who accepts

[64] Thad A. Brown, *op. cit.* Page 128.

and who rejects the rumor), i.e. the differentials, both in initial configurations and those disturbed by the rumor[65].

4.5.4 Percolation Theory

Percolation is a technical neologism that means filtration. Closely related to cellular automata models, it was born during World War II when Flory and Stockmaker[66] employed it to describe how small bifurcating molecules formed increasingly bigger molecules as more chemical links were established among the original molecules. This polymerization process can lead to chemical link chains or networks throughout the system.

In the Percolation Theory, small molecules belong to squares, the macro-molecules to clusters and the network to the percolation cluster.
However, the Percolation Theory concept as such was first mentioned in 1957 in a paper published by Broadbent and Mammersley, which introduced the term applied to their analysis of the filter effect phenomenon from the mathematical perspective using geometrical and probabilistic[67] concepts.

To understand this theory, you need to imagine a matrix or square pattern as in figure 1(a). This pattern could be so big that any effect formed in the system's boundaries or edges could be considered insignificant and therefore worthless.
In physics, this type of system is called square lattice; mathematics assigns the symbol Z^2 to it, while our common sense identifies it with a large piece of square patterned paper.

Now imagine that a certain portion of the squares of this system contain a big dot in the center, while other squares are empty, as in figure 1(b). Based on this assumption, we define cluster as the group of neighboring squares with dots framed by circles as in figure 1(c). These figures show what is called immediate neighbors, i.e. the cells that share a side. Those which only share their corners or vortexes do not qualify as immediate neighbors; they are considered mediate neighbors in this model.

All the sites included in a cluster are those connected among themselves by an uninterrupted connection chain of squares containing a dot.

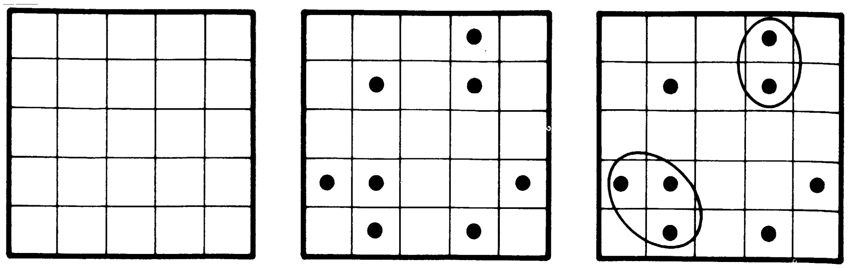
One of the interesting questions to determine is about the dot distribution criterion in the matrix - in other words, the criterion ruling the occupation of sites. We may think that all dots have a reciprocal union affinity among each other, or else that they reject each other and try to be mutually distant. However, it is logical to assume that they simply ignore each

[65] Thad A. Brown, *op. cit.* Page 129.

[66] Staufer, Dietrich and Aharony, Amnon: *Introduction to Percolation Theory*. Taylor & Francis, London 1991. Page.1.

[67] In his work *Percolation Structures and Processes,* Hammersley says that the new computers available to the scientists of the time were one of the reasons for the development of the theory. In fact, the power of computers is of vital importance to study and analyze the percolation process in square lattice simulations of billions of sites.

other. From this perspective, squares are randomly occupied by dots, i.e. each square is either occupied or empty regardless of the occupation status of the neighboring square.



1(a) *1(b)* *1(c)*

Fig. 1 Definition of percolation and its clusters: (a) shows parts of a square matrix; in (b) some squares contain dots; in (c), the dots in the cluster, i.e. neighboring occupied sites, are circled except when the cluster consists of one occupied site.

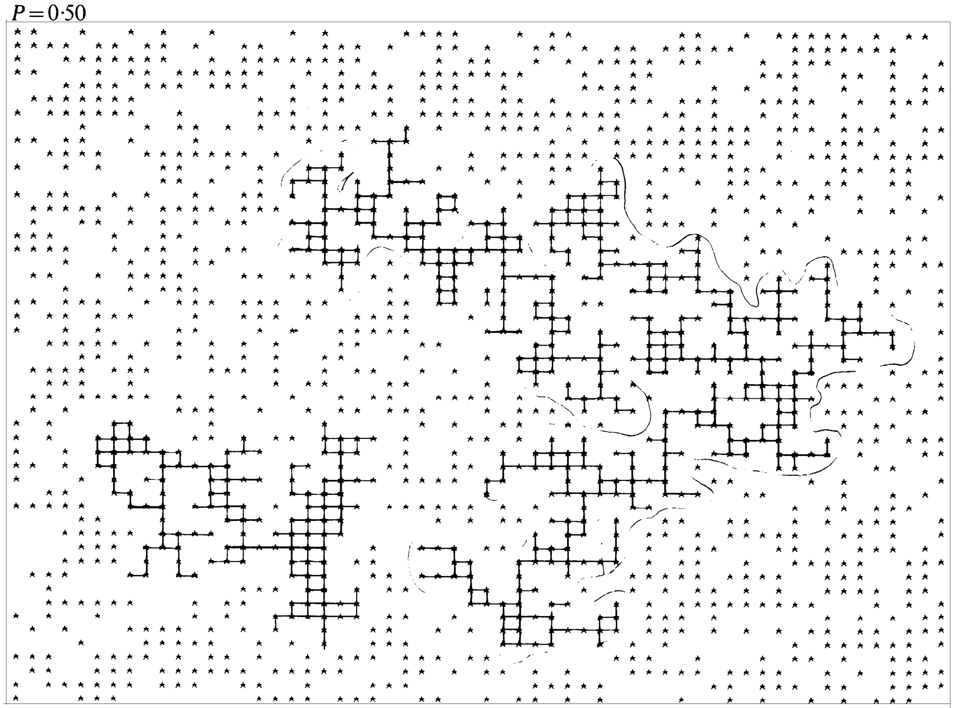
The probability of a site, i.e. a square, to be occupied by a dot is called p. This means that N squares in the square matrix, N being a very large number, pN is the degree of probability for these squares to be occupied, while (1 – p)N represents squares that are not occupied, i.e. empty squares. Again: each site in a large matrix is randomly occupied with a probability p, regardless of what may happen with its neighbors.

The Percolation Theory studies the clusters formed, i.e. the formation of neighboring groups of occupied sites, their quantity and their properties.

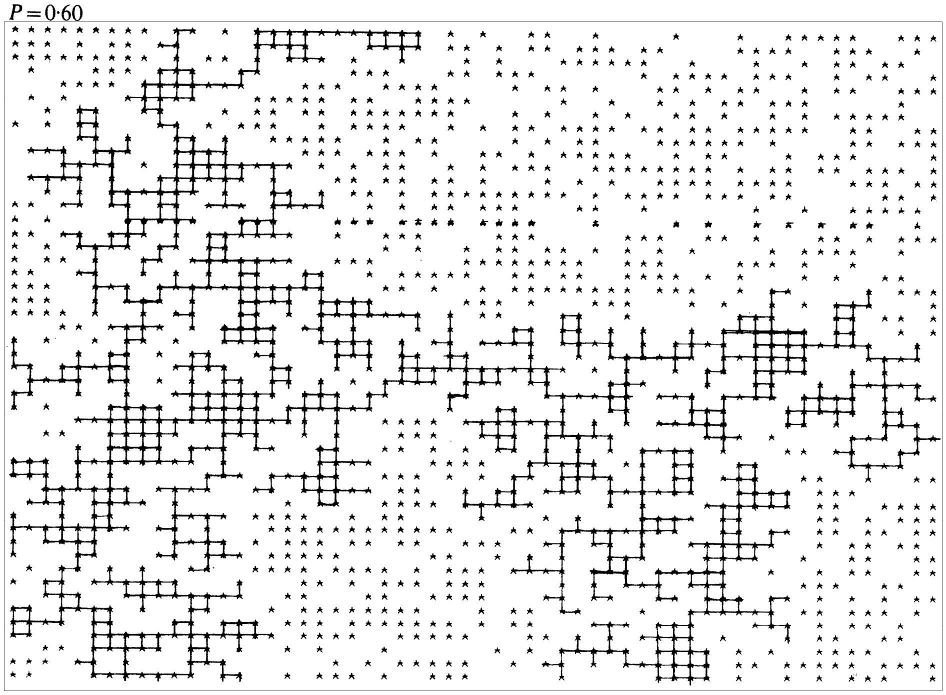
Figure 2 shows three stages of a 60 x 50 computer-generated square matrix, with a probability p of occupation increasing from 50% to 70%. In the example, it is clear that for p = 0.6, a cluster extends from the top to the bottom and from left to right. It is said that the percolation shown by this cluster throughout the system resembles that of filtering water in a coffee machine filter.

One of the most attractive points for scientists devoted to the study and analysis from the perspective of the Percolation Theory is that of the peculiar effect close to p_c, called critical phenomenon; it occurs when a cluster is first produced during percolation.

$P = 0{\cdot}50$



$P = 0{\cdot}60$



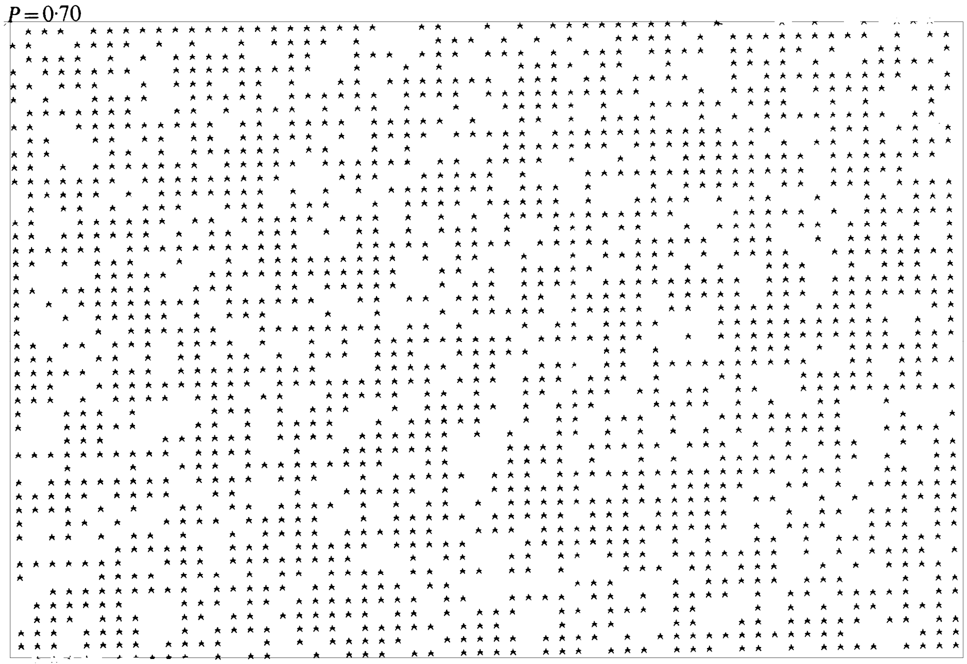


Fig. 2 Three stages of an example of percolation in a 60 x 50 square matrix for several p as indicated. Occupied squares are marked with the symbol H, while the empty squares are ignored. The biggest cluster is marked close to the concentration of the 0.5928 threshold.

4.5.4.1 The Percolation Theory Applied to Rumor Diffusion

The analysis of rumor from the perspective of the Percolation Theory enables us to find out how long a rumor will take to penetrate into a population and how long it will take to extinguish.

Let us assume that the population to be analyzed is represented by a square lattice where each individual or "site" occupied by a dot represents an individual that will be called "susceptible", and each empty site represents an individual who ignores rumors and will be therefore called "resistant". The probability for a site to be occupied by a susceptible individual is p and the probability for it to be occupied by a resistant is (1 – p). For p = 1, all sites will correspond to susceptible individuals, which would result in a situation of absolute incongruity since this is not so in a social system. p < 1 (i.e. the probability for all individuals to be susceptible is lower than 100%) implies a more coherent population distribution, with degree of relative disorder between the population of susceptible and resistant individuals.
Now let us assume that some susceptible individuals pass on a rumor. We will call those the rumor was passed on to "infected". The simplest alternative of the model is to infect all the individuals in the first row of the lattice; consequently all the other individuals in rows 2, 3,..., L of the L $\times$ L lattice will remain susceptible. The question is: can this process initiated in one side of the lattice penetrate all the population up to the end row L?

At this point it is worth clarifying how a susceptible individual can infect another susceptible individual (not resistant ones since they refuse to accept and re-transmit a rumor).
In order to simplify the simulation model, the analysis of the lattice will be done in a regular fashion, taking susceptible individuals in the first row first, from right to left and checking how many neighbors they infect; then we take the second row analysis in the same way and so on until susceptible individuals in the last row have been reached.
It is assumed that during the whole simulation process, susceptible individuals are -and become- infected, as long as one of their immediate neighbors is at the same time, another infected individual. Thus, when the lattice is swept for the first time, i.e. within one time unit, a recently infected individual infects his neighbors, those at the bottom and on the right. During the next sweeping, i.e. in the next time unit, the same process is repeated with his other two neighbors, the ones at the top and on the left. When it reaches the end, the process starts in the first row, but this time from left to right. Each sweeping instance across the whole lattice is, as we said before, a single time unit in the simulation.
It is also assumed that rumors can be exclusively transmitted to susceptible individuals who are immediate neighbors, i.e. those who are in direct contact, instead of those mediate neighbors (who only share their corners) or those who are more distant. On the other hand, for the purpose of this simulation, we also assume that a susceptible individual infected by the rumor during a time period (and who has probably infected others) is considered crossed out for the remaining time periods (in epidemiological models it would be deceased).

Finally, the rumor transmission process is considered to have come to an end once the last row has been reached or there are no more infected individuals in the population: in the first case, and as long as the computer has been programmed with a very large square lattice, transmission would reach the next row of susceptible individuals; in the second case, only crossed out individuals and susceptible individuals next to resistant ones would remain. The former as ex-susceptible-now-infected and crossed out by the system, and the latter because they are susceptible individuals who have never been in direct contact with a transmitter and therefore, they have not been rumor-recipients.

The life of the rumor transmission process is determined by the number of sweeping instances through the lattice until the end of the process, involving a meaningful number of distributions of susceptible individuals across the sites of the same lattice with the same probability p.

Figure 3 shows the lifetime of the rumor as a function of probability p of a square or site being occupied by a susceptible individual. The present and simple computer simulation shows that there is a very precise transition for the above-mentioned case close to $p = 0.6$, where the lifetime seems to come close to infinite. Obviously, from a simulation with a finite matrix, we cannot produce an infinite duration; however, the process can be simulated to the same “critical” value of p close to 0.5928, but for matrixes of different sizes, and show that the lifetime extends as the population increases.

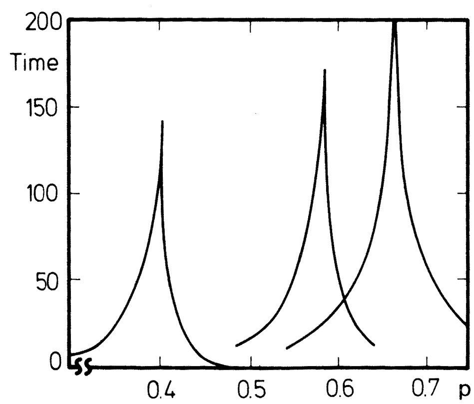


Fig. 3 Average time indicating the end of a rumor transmission process according simulation in a square matrix. The curve in the middle corresponds to the variable described in the text. The one on the left shows the case when a rumor is transmitted to immediate neighbors and mediate neighbors, as in a social uproar situation. On the contrary, to obtain the curve on the right, two neighbors (instead of one) are required to transmit the same rumor to the same person for the latter to consider it trustworthy and credible.

There is a special value in the probability of occupation of sites p, called threshold of p_c percolation, where the lifetime seems to diverge. For p close to the unit, each row can immediately transmit, i.e. infect the rumor to the susceptible individuals on the next row, thus reaching transmission to the last row, after lattice sweeping. On the contrary, at the other end, for p close to zero, most of infected individuals have no neighbors to transmit the rumor; therefore the transmission process stops once they have been crossed out. In this way, after a couple of sweeping instances, there is no possible infection in the system. However, if we increase the probability of sites being occupied by susceptible individuals, i.e. if we gradually increase p from a low value to an increasingly higher one, at a certain critical value $p = p_c$, there is a pattern of susceptible neighbors that will connect the upper row for the first time, i.e. the top of the lattice to the base. This is what we call percolation cluster.

With p slightly over p_c, the smallest pattern created by this percolation network to connect the upper row and the last one at the bottom, is called minimum pattern and will generally greatly differ from a straight line. Figure 4 shows a typical pattern of these characteristics.

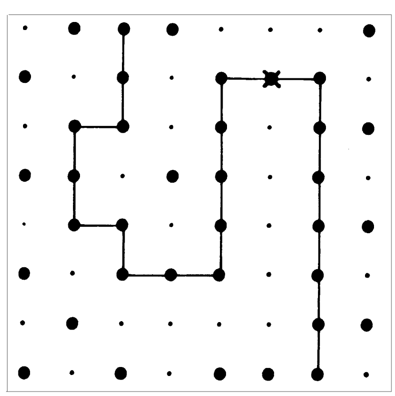


Fig. 4. Example of the smallest pattern connecting the upper and lower rows of a small square lattice, where probability of site occupation p is over p_c. The straight section of this

line connects the center of occupied squares. "x" shows the site which, if not present due to a small reduction of p, would disconnect the upper rows and those at the base of the lattice, although it would still generate a long life, until the simulated rumor transmission process came to an end.

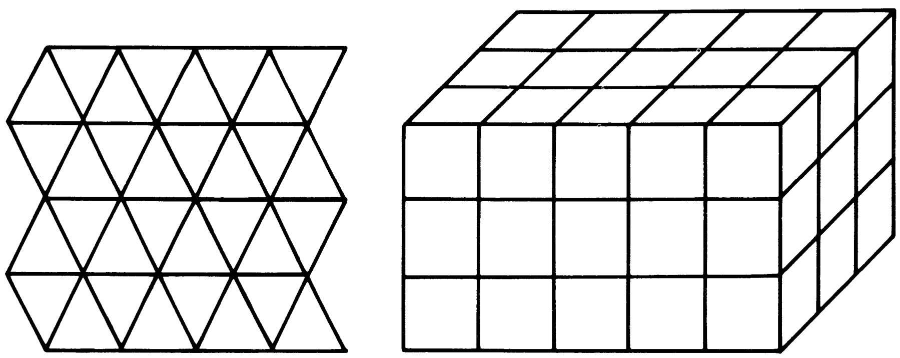
Since the model previously described is very simple, the rumor transmission process preferably develops from top to bottom, or from left to right of the lattice, and it would need much longer to develop inversely. For four consecutive steps in the progressive top-bottom sense to occur, the system requires one time unit, and the same number of backward steps would require four time units.
If p is reduced to a value slightly below p_c, some susceptible individuals may disappear, for example the one marked with an "x" in figure 4. The transmission process, in that case, needs a long time to reach the conclusion that the rumor will not be able to cover the whole population, and it will therefore extinguish only after several sweepings through the lattice. Thus, if the value of p is close to p_c, whether higher or lower, the life of the rumor will be much longer.

Figure 3 shows the result of two variants in the model described. In one case, the one of the curve on the left, the transmission process has been allowed to develop not only towards immediate neighbors (squares with one shared side) but also towards mediate neighbors (squares with one shared vortex or corner). This is the case when, due to social excitement, individuals transmit rumors beyond their groups of belonging. In the example, the critical point has moved to almost 0.4. Research has shown that this is equivalent to a unit minus the critical value, for example, 1 – 0.5928 = 0.4072. Neither extraordinary mental skills nor computer calculations are needed to understand that now rumor transmission can develop more easily since it can jump across higher distances. In this case, the percolation threshold is obviously lower.
The other variant has to do with the opposite case of the example in the last paragraph and assumes that the population of individuals is immersed in a quiet sociopolitical context. Since there is no degree of social excitement favoring rumor diffusion, an individual susceptible to its transmission needs his two immediate neighbors to be infected and transmit the rumor instead of one, for him to take it as true information and be willing to re-transmit it. Transmission obviously becomes more difficult for the percolation point to be reached; hence its threshold increases, as shown by the curve on the right in figure 3.
The last comment in connection with this point is that the percolation threshold $p = p_c$, shows the position of a phase transition. Remember that, during phase transition, a system shows qualitative changes in its behavior as a result of a specific value in a parameter. In the case of percolation, if p easily increases from zero to one, $p < p_c$ will not show percolation threshold, but there will at least be one for $p > p_c$. Thus, when $p = p_c$, and only in that case, something peculiar occurs: for the first time a pattern of susceptible neighbors emerges and it connects the system's top with the bottom, i.e. the rumor goes through the whole population of individuals although not necessarily 100% of the population has been infected by such rumor.

The divergence of characteristic times in the life of the rumor in the critical point shows analogies with other phase transitions where it is called critical slow motion point. For example, the case of temperature slightly lower than that of liquid gasification, where it is as if the fluid were not certain to remain liquid or to turn into the gas. This uncertainty status demands a great deal of time from the system to decide how to behave.
The simplified model described here does not respond to reality completely. Life is much more than a square matrix and social actors are more than dots in a square pattern. The

Percolation Theory understands this; it has therefore developed more complex variants: triangular matrixes, honeycomb matrixes, and other bi-dimensional shapes, including simple geometric-body-centered cubic matrixes, or face-centered, and diamond-type matrixes, among others. Matrixes with dimensions over 3, usually applied to testing different theories, are treated as hypercubic matrixes.

Figure 1 defined the sites of the square matrix as the center of each of the squares represented in it. Another definition may be sites at the cross points of the matrix lines.
The situation in figure 5(a) is different. If the matrix sites are placed at the cross points of the lines of this figure, a triangular matrix is obtained; but if instead we place them in the center of each triangle at equal distances from each surrounding line, a honeycomb-type matrix will be obtained.
Figure 5(b) is formed by cubes. It reminds us of the famous Rubik's cube game and mathematicians call it Z^3.



(a) (b)

Fig. 5. Definition of triangular, honeycomb and cubic matrixes. In the triangular matrix, each line intersection in (a) corresponds to a site in the matrix; in the honeycomb-type matrix, the sites are formed by the center of each triangle in (a). The simple cubic matrix consists of the corners of cubes in (b); in the body-centered cubic matrix the site is in the spatial center of each cube and in the corners; while in the face-centered cubic matrix, the sites are in the center of each of the six faces of the cube and in the eight corners.

In the body-centered cubic matrix, the sites are located in the spatial center of each cube, and in their eight corners. Instead, in the face-centered cubic matrix, the sites are represented in the center of each of the six faces of each cube and in their eight corners. Diamond-type matrixes are complex to program and therefore they are not very much liked by researchers. Instead, five dimensional hyper-cubic matrixes are easier to handle.
As in the case described, in each of these matrix, each site is randomly occupied with probability p and emptied depending on probability (1 – p); clusters are the groupings or bunches of neighboring sites occupied by susceptible individuals.

Although the present description stands for site percolation, link or connection percolation also exists and it is of utmost relevance for the study of rumor diffusion. In this type of percolation, all the sites of the matrix are occupied and the lines connecting neighboring sites are different. Each of these lines can create an open connection (communicates) according to probability p, or closed (does not communicate) according to probability (1 – p).

As per rumor, the model could be of utmost interest because the analysis should not concentrate on the individuals themselves but on whether or not they communicate the rumor to each other at a certain moment and the consequences in the system as a whole.
Another interesting aspect shown by Stauffer y Aharony[68] in their development of the Percolation Theory is that the resistance offered by the system to percolation increases linearly as the distance between the first and last row of the matrix increases, i.e. the population of individuals. It is also surprising that the geometry of clusters of infinite lifetime with probability $p = p_c$ is of fractal dimension, i.e. its shape repeats itself regardless of the size of the population, as shown in figure 6.

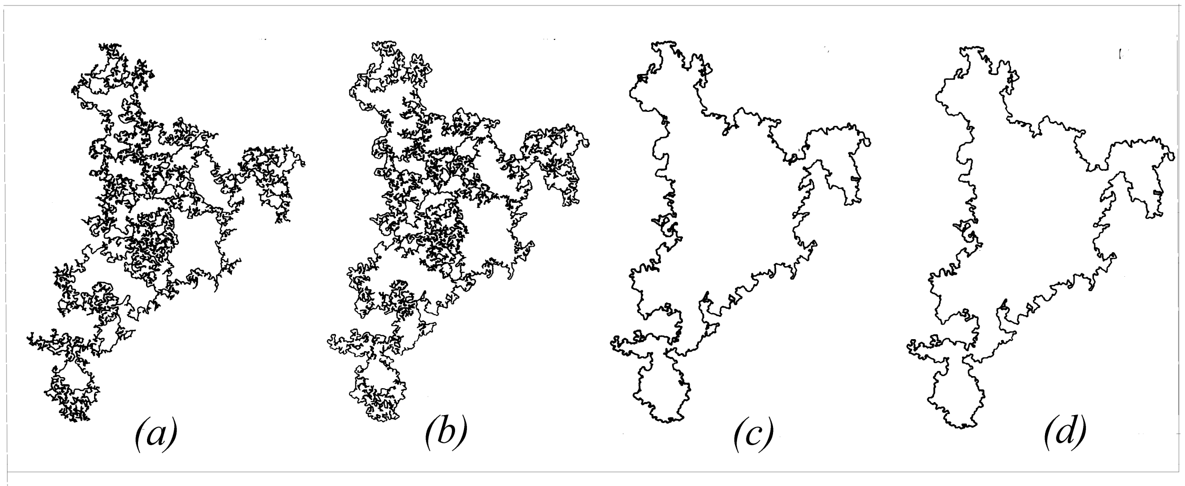


Fig. 6: "Cortex" y and accessible perimeters of a large cluster in a square matrix, $p = p_c$: (a) the whole cortex (10 734 sites); (b) perimeter of E_1 (10 932 sites); (c) perimeter of E_2 (3560 sites) y (d) perimeter of E_3 (3284 sites)[69].

4.5.5 Strategic Interaction

Cooperation has been carefully analyzed by Nowak, Szamrej, and Latane who developed a cellular model of change of attitude by employing a unit network that influence other units through support (strengthening the recipient's unit current attitude) or persuasion (by attempting to change the recipient's unit). Thus, at each interval of discrete time, the opinion of each unit (individual) is updated as the sum of the persuasive behavior of other local (group) units (individuals). These simulations determine the necessary conditions for change of opinion, which can be acceptance or rejection of the rumor[70].

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[68] Staufer, Dietrich and Aharony, Amnon: *Introduction to Percolation Theory*. Taylor & Francis, London 1991. Page 151.

[69] Excerpt from Grossmann, T. And Aharony, A.: *Hulls and Perimeters*. J. Phys. A., 20, L1193 (1987), published in Staufer, Dietrich and Aharony, Amnon: *Introduction to Percolation Theory*. Taylor & Francis, London 1991, Page 130.

[70] Thad A. Brown, *op. cit.* Page 129.

Models of social interaction investigated by means of cellular automata may open up for communication sciences issues as yet unapproachable. We know that within strategies for solving common collective choice problems, cooperation (or conflict) may appear to be stable or even frozen while it can also instantly disappear with the slightest nudge or noise (we will later analyze the perspective of rumor from the Conflict Theory perspective). Cellular automata can model conditions where a large number of actors make many decisions, as in any complex community where individuals interact with imperfect (ambiguous) information.
Determining how levels of cooperation or conflict are reached is a core element in the prisoner's dilemma[71] research dealt with in Chapter I: Informal Channels of Communication. In fact, applying agents of the prisoner's dilemma cellular automata models can throw interesting results when the iterative model is applied. As said before, this is a two-person game to model the evolution of either cooperation or conflict. Each player on every round can choose between cooperation (C) or defection (D), and a standard payoff matrix, V, determines the outcome.

	Cooperation **C**	Defectionn **D**
Cooperation **C**	**R , R**	**S , T**
Defection **D**	**T , S**	**P , P**

*where **T>R>P>S** and **2R > T + S.***

In a one-shot play of the game, each player's best strategy is to defect, since **D** gets the largest payoff, **T**, while **C** would get **S**. The paradox is obvious. In finitely repeated plays of the game, all equilibrium have the property that no matter how long the sequence, a non-cooperative outcome occurs in each period. In games of an indeterminate duration, however, the player's utility is calculated on the expected long-run payoff of repeated one-shot plays.
In essence, it is best to figure out how to cooperate, since if both players use **D,** both end up with a lower payoff since **R > P**.

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[71] Fernando Aguiar, *La Lógica de la Cooperación.* In: Fernando Aguiar (edit.): *Intereses Individuales y Acción Colectiva*. (Madrid, Editorial Pablo Iglesias. 1992), Pages 10-42

When the iterative prisoner's dilemma was examined within difficult environments, Richards showed the clear potential for chaotic behavior[72].
In exploring evolutionary games played with neighbors on a spatial lattice, the most common approach is to set each lattice cell to a single strategy. The strategy may be either fixed[73] or allowed to evolve based on a generic algorithm or other optimization hill-climbing routine[74].
As before, the lattice mechanism is quite simple. All cells are updated simultaneously; the score of the cell is determined to be the average it obtains playing the neighbors defined by the given radius; the score of the cell is then compared to the scores of the neighborhood and the cell itself; the cell adopts the strategy of the highest score within the sites defined by the radius. Adding a touch of noise to the scores usually breaks ties, when they occur. As was observed above, the scores of the defined neighbors are dependent on the strategies of their defined neighbors, and so on. Thus, the contextual influence on any cell extends beyond the defined radius. When the model is restricted to set strategies, it clearly qualifies as a cellular automata.

To illustrate, let us examine one set of recent findings on the iterative prisoner's dilemma. In a paper, Nowak and May use fixed strategies of cooperation (C) and defection (D) to study how cooperative behavior evolves and is maintained[75]. As mentioned above, nearly all prior work demanded that individuals or groups remember past encounters, with some discounting of retrospective evaluation for prospective payoffs (using fixed strategies means that memory is not a requirement to model behavior).
On a two-dimensional lattice of varying sizes, interacting players face the following payoffs: **R = 1, T = b (b >1), S = P = 0.** The parameter **b** identifies the relative advantage of defection versus cooperation. (Mutual cooperation therefore score 1; mutual defectors score **0**; **D** scores **b** against **C**, who receives **0**. The results are not altered when **P =** ε , when **0 <** ε **<< 0**. **T > R > P > S** remains strictly satisfied).

The entire lattice is occupied with **C**'s or **D**'s and again the scoring is the sum of encounters with neighbors. At the start of a next generation (a time-step) each cell is occupied by the player with the greatest score among the previous owner and the defined neighbors. The radius and the boundary conditions are varied. The rules among the $\mathbf{n^2}$ players on the **n x n** lattice are deterministic. Updating of sites occurs in discrete time and in synchronous fashion. According to Nowak and May[76], extremely complex patterns are achieved when strategies are fixed (that in essence involve no strategies at all). What they show is that ecological structure of cooperation stems from the magnitude of the advantage given to defecting, the value of **b** (relative advantage of defection before cooperation). For example, the initial configuration starts with 10 percent defectors when **b** is between 1.75 and 1.8, indicating the prevalence of cooperation. When the **b** parameter

[72] Thad A. Brown, *op. cit.* Page 130.

[73] Thad A. Brown, *op. cit.* Page 130.

[74] Thad A. Brown, *op. cit.* Page 130.

[75] Thad A. Brown, *op. cit.* Page 130.

[76] M. Nowak and R. May, "Evolutionary Games and Spatial Chaos, *Nature* (359: 826-29, 1992), Cited by Thad A. Brown, *op. cit.* Page 130.

is moved to values between 1.8 and 2, the lattice evolves. Nowak and May interpret their result as indicating that **C** and **D** “coexist indefinitely in a chaotically shifting balance, with the frequency of **C** being (almost) completely independent of the initial conditions”.

4.5.6 Connectivity

An important aspect of complex systems of rumor transmission is that most of them are of parallel operation, i.e. all the parts operate simultaneously. This allows for multiple form or multiple-located characteristics, i.e. redundancy. A good example is the brain, where damages are frequently bridged, thus allowing the restoring of functions along time. This strongly contrasts with, e.g., a car: if one part malfunctions, it leads to the malfunctioning of the system until the damaged part is replaced by another.
Since in complex systems we do not organize the parts but instead we let them find their own state because of their self-organization property, it is obvious that we have no control on the connections and structures they develop.

This is similar to a filter problem, percolator, where we want to establish a connection between two areas despite certain barriers. In how many ways can this be done? There is a substantial difference in this question between traditional science and complexity science. In the first one, we generally have a formula, the “rule” the system is subjected to. According to the Complexity Theory, if we modify one of the parameters (or constants) we obtain a new rule and new solutions. If we take all the possible parameters and we analyze them, we can then reach a family of solutions. We can then infer the potential behavior of one complete class of solutions and this will enable us a better understanding of the system’s open possibilities and the parameters’ combination. We can also deduce the relative frequencies of static- orderly and chaotic- states.

The variables initial values in each solution can be multiple. From each of these initial positions, the system will follow the phase-space trajectory. By plotting all these possible trajectories in a graph, we will obtain the phase image for this solution, a map of the present attractors. Each solution will have a separate phase image. Rather than the internal structure of each individual solution, what we are interested in analyzing here is their variation with their changing parametric values. This treatment is frequently shown as a bifurcation diagram, a kind of bi-dimensional “slice” through a three-dimensional image. Looking at the end of this diagram we would move through a succession of phase-portraits.

It is useful to consider this type of family of solutions as our system’s alternative maps. Imagine activity islands in static or chaotic oceans. There are many possibilities of alternative geographies, depending on the arrangement of the parts. To obtain a whole useful structure for analysis, islands interconnected (by bridges) are required. Thus, the information may filter through the system, as the rumor spreads and filters in groups through communication channels to the fractal scale, as when we make connections between different ideas in our brain: interconnected autonomous modules as in a “mind society”.

It is difficult to evaluate what type of connectivity is optimal to achieve a maximum emergent. It depends on the parts complexity (agents, interacting parts). If they only have two states, 2 inputs seem to drive the system to the edge of chaos (technically speaking,

an NK system, where K = 2 and N parts). The lower the number of connections the system freezes; the higher the number, its behavior turns chaotic. Systems frequently self-regulate. Changes act to increase or reduce complexity until the maximum order emerges. For this to happen, it is necessary to consider systems whose number of connections can vary, and that may also have the capability to decide which number is the optimal individual figure (local aptitude). This is possible thanks to random evolution modes (a change can add a new sensitivity or can inhibit another) and design (individuals or groups can decide with whom to interact and/or how many concurrent interests to pursue).
The example of a committee shows how this works. If all members stick exclusively to their own ideas (in other words, if they look down on the other's ideas) a decision is unlikely to be reached. This is the well-known "dead end" (a static situation, with zero connectivity). If they all take into account the point of view of the other members (reacting before each member of the group), again a decision is unlikely to be taken, since hesitation governs (a chaotic oscillation situation between one point of view to the other, maximum degree of interconnectivity). But when members finally start to group themselves, creating bigger organized blocks, and adjust connectivity to maximize their own advantage while ignoring useless connections and increasing favorable ones, this is what is normally called "lobbying". The system self-organizes towards a state where the maximum benefit is obtained (assuming all members count with identical degree of power).

Similarly, we can adjust our own behavior to optimize what we do: finding alternatives if we are bored, or else leaving whatever we are busy with, if we are overwhelmed or under pressure.

4.5.7 Granovetter's Threshold Concept

Mark Granovetter, professor of sociology at Harvard and Stanford, analyzed collective behavior models in those situations where the participants count with only two alternatives, and where the cost-benefit ratio depends on how many participants choose each alternative. The key concept of these models is threshold, i.e. the number of people who will take a decision before a given participant does; this is the point where net benefits start to exceed net costs for that specific participant[77]. This concept is particularly related to the neighbor influence of the cellular automata systems and the iterative prisoner dilemma.
On the bases on the distribution of threshold frequency, these models calculate decision-makers' final or "equilibrium" number.
Collective behavior models are about the summation of individual preferences; they do not examine why individuals prefer what they actually choose. They are about binary decisions, where the participant has two different mutually excluding alternatives of behavior and decides to do something (accept and pass on a rumor) or not to do it (kill the rumor).

These models' collective results can seem paradoxical, i.e. intuitively incompatible with individuals' intentions that generate them. According to Granovetter, this possibility is

[77] Mark Granovetter, *Threshold Model for Collective Behavior*. In Spanish in: Fernando Aguiar (edit.): *Intereses Individuales y Acción Colectiva*. (Madrid, Editorial Pablo Iglesias. 1992), Pages 71-102

extinguished if we accept that collective results reflect old or new rules of most of the participants. Thus, these models are applied to processes that are not normally called collective behavior, such as voting, household segregation, strikes, migrations, markets, and rumor diffusion[78].

Collective behavior models assume that individuals are rational and that given their targets, preferences and the perception of their situation, they act to maximize their benefits. Different individuals need different levels of confidence before re-transmitting a rumor; the resulting benefits of re-transmission are different as well. As seen in Koenig, the generator -socially isolated individual- will attract attention to himself; the transmitter or insider will pass it on to show that he belongs to a selected group (and enjoys the power typical of possessing information others do not possess), and the resistant, skeptical or immune, stops the rumor -for questions of principle or for fear to be ridiculed if the rumor is discovered to have been just a lie[79].

Threshold is the key concept to describe such variations among individuals. A person's threshold to adhere to a rumor, as said before, is the percentage of the group he would need to see adhere to the rumor before actually adhering himself. The transmitter's threshold will be very low since passing a rumor has a high benefit for him, while the cost and negative consequences of doing so are low. For some -like the generator- passing on a rumor may be so beneficial that they have a 0% threshold. The generator will transmit a rumor even when nobody else is doing it (for example, because the rumor is unlikely) . Granovetter calls them instigators.
Conservatives -resistant in our case- will have a very high threshold: the benefits of rumormongering are either small or negative for them, while the consequences of lack of prestige are high, since they probably are "respected citizens who only speak when they are certain". Their threshold is usually 80% or 90%. The threshold of the principle-oriented individual, who not only disbelieves rumors but who systematically contradicts them, can be 100%.

Granovetter's model is relatively similar to Wheeler's model, known as behavioral contagion[80]. According to Wheeler's formulation, the cost-benefit analysis is considered an approximation-avoidance conflict, and contagion occurs when the observation of the behavior of another individual pushes the approximation tendency above avoidance (equivalent to the definition of threshold, as the point where benefits exceed costs).

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[78] When a structure changes from a collection of many disconnected parts to a great and single conglomeration we said that a "percolation process" has taken place. In his observations, Koehler has define the moment of this switch as the percolation threshold. "At a critical value" –he says- "the percolation threshold, the number of parts, and their interconnectedness seem to become glued together into one big irregular lump. Peithen, Jurgens, and Saupe tell us that, 'Right at the percolation threshold this maximal cluster is a fractal!' ". (Koehler, Gus: "Fractals and Path-Dependent Processes: A Theoretical Approach for Characterizing Emergency Medical responses to Major Disasters". In: Robertson, Robin y Combs, Allan (edit.): *Chaos Theory in Psychology and the Life Sciences*, Lawrence Erlbaum Associates, Publishers, New Jersey, 1995. Page 204).

[79] Fredrick Koenig, *op. cit.*

[80] L. Wheeler, "Towards a Theory of Behavioral Contagion", *Psychological Review* (Nº 73, March, 1966), Pages 179-192, Cited by Mark Granovetter, *op. cit.*, Page 75 (note).

However, Wheeler's model does not consider how many individuals may be needed for somebody to reach this point, or the cumulative effects of those before the last person.
In the broader context of threshold models, the idea of contagion seems inadequate because it implies more than the simple imitation of the last person observed. In this sense, the threshold model resembles the models used in epidemiology.
Granovetter mentions several cases where threshold models are pertinent; among them, innovation diffusion, strikes, voting, social gathering departure time, migrations, and rumors. In connection with rumors he says that only after hearing a rumor it can be spread. But people's gullibility varies and some may need to hear it from several people before believing it and passing it on. These credibility levels, says Granovetter, are the same as thresholds. A formally identical situation is the spreading of a disease, where gullibility is replaced by vulnerability. People differ as to the number of infected people they have to be exposed to in order to be affected by the disease.

The purpose of these models is, in all cases, to predict –based on the initial distribution of thresholds- the final number or percentage of decision-makers. From the mathematical point of view, the problem is to find the balance in a process that occurs along time. The following example will help clarify this concept: imagine a group of 100 blue-collar workers in an uncertain situation due to the probable closing of the plant. Let us imagine that their rumor thresholds are distributed like this: there is an individual with threshold 0, another with threshold 1, another one with threshold 2, and so on, up to the last worker with threshold 99. This is a uniform distribution of thresholds. The result is clear, and could be described as an adherence or domino effect: the 0-threshold individual, the rumor generator, passes on the version about a massive layoff by the end of the month due to the closing of the plant. This activates the individual with threshold 1; rumor transmission of these people activates the individual with threshold 2, and so on, until the whole group of one hundred members in the staff adheres to the rumor. The balance is 100.
Let us modify this distribution: we replace the individual with threshold 1 with another with threshold 2. According to the habitual manner of describing groups of people, both groups are identical, but in the second case the result is different. The generator launches the rumor, but now there is nobody with threshold 1, and consequently the rumor ends and dies at that point, with a single (generator) transmitter.
This simple example shows Granovetter's main discussion as to the danger of inferring individual dispositions from aggregated results. In the first case rumor diffusion will be seen as collective action. In the second, as the isolated action of an individual trying to agitate his co-workers. However, we do know that both groups are almost identical in composition. The difference as to the result solely depends on the aggregation process and specifically on the continuity of the frequency distribution as regards the second case.

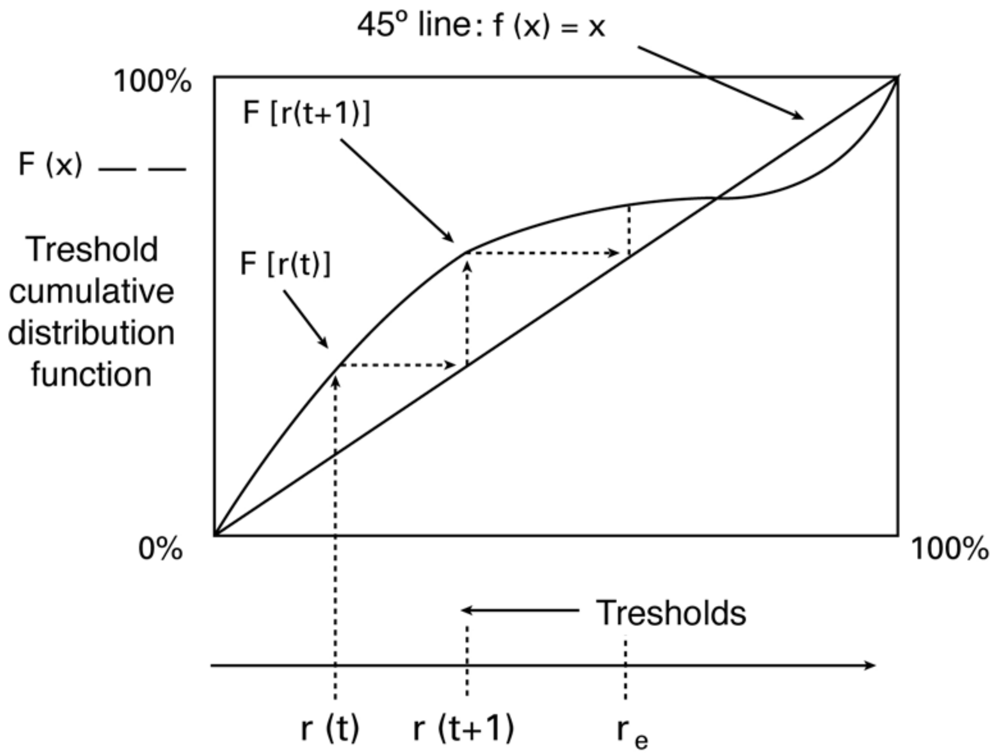
Threshold models can be valuable to understand situations in which the middle level of preferences clearly favors a specific action, but the action is not performed.

Threshold models can determine a precise mathematical expression as to the change from a threshold frequency distribution to a result of equilibrium. **x** stands for thresholds, **f(x)** for frequency distribution, and **F(x)** for the cumulative distribution function **(c.d.f.)**, where c.d.f. is the percentage of population with a threshold lower or equal to **x**.
The population percentage that has adhered to a rumor at time **t** (in discrete time periods) is called **r(t)**.
Let us assume we know the population percentage adhering to a rumor **r(t)** for **t**; for example, let us imagine we know that after two time periods **(t = 2)** 60% of the people passed on the rumor. So, what percentage of individuals will transmit the rumor at **t = 37**?

According to the definition of thresholds, it is the percentage of individuals whose threshold is lower or equal to 60%. This process is described through the differential equation **r(t+1) = F [r(t)]**.

In those cases where the distribution of frequency is simple, the differential equation can be explicitly resolved to express **r(t)** for any **t** value. So, by establishing that **r(t+1) = r(t)**, the equilibrium result can be found.
When the function is not simple, equilibrium can be calculated through infinite recourse. In this simple version of the model, where the “elimination” of participants has not been considered, **r(t)** oscillatory behavior is not possible and equilibrium will always be achieved.

According to Granovetter, some graphic observations show that equilibrium points can be calculated without differential equations or infinite recourse.



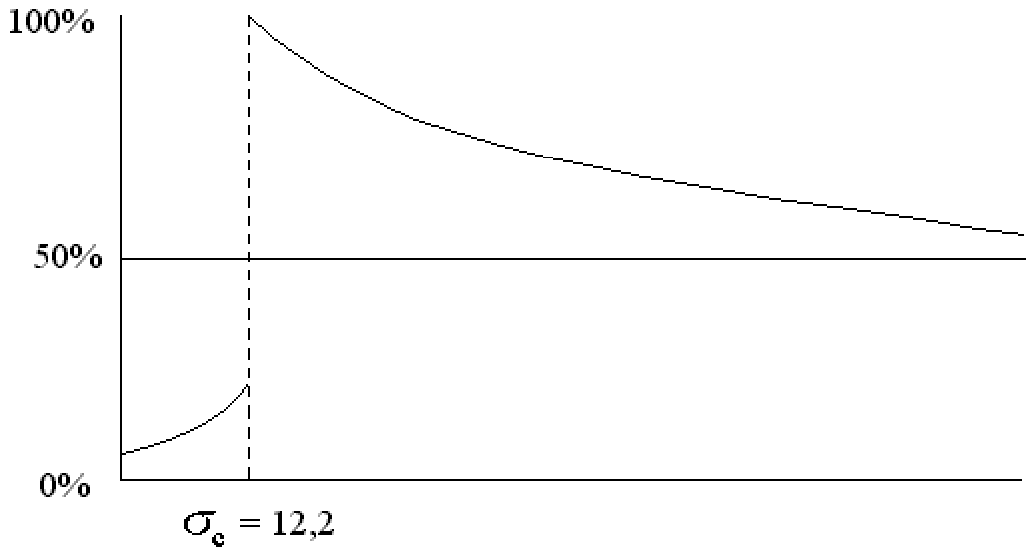
Graphic method to find the point of equilibrium of threshold distribution. ***R(t) =*** *percentage of those who have transmitted rumor at time* ***t****.*

In the figure above, thresholds **(x)** are graphically contrasted against the cumulative distribution function **c.d.f [F(x)]**.
As before, let us imagine that **r(t)** is known. Since **r(t +1) = F[r(t)]**, we can find the percentage of transmitters in the next time period following the left arrow from **r(t)** to the point immediately above **c.d.f.** axis. To locate this point on the **x**-axis, we follow the horizontal arrow up to the 45º line, **F (x) = x**.
This procedure can be repeated to find **r(t +2) = F[r(t + 1)]**, and so on. For **c.d.f.** (cumulative distribution function) represented in the figure, the horizontal longitude of the

arrow tends to **0**, and **r(t)** has a limit value called point of equilibrium. This limit is the point where **c.d.f.** first crosses the 45º line from above. The equation **F(r) = r** shows the point from the algebraic perspective.

This model can consider the populations where there is no distribution of preferences as to the regular variation of a key tendency. The results obtained are surprising because they show effects contrary to intuition as to what may be expected.

Let us take the 100 blue-collar employees whose thresholds are normally distributed at an average of 25 thresholds. Now the question is: what is the effect on the equilibrium result if the distribution standard deviation varies with a fix mean.
Up to a critical point σ_e, the equilibrium number of rumor transmitters increases gradually up to 6 (vertical scale). Then, after that point (approximately 12.2 on the horizontal scale), the value of r_e jumps to near 100, and it decreases thereafter.[81]



r_{e} = *Number of rumor transmitters for equilibrium*
σ_{e} = *Standard deviation*

Equilibrium number of rumor transmitters, as a function of the standard deviation of threshold normal distributions; medium =25, N = 100.

From the mathematical point of view, this is explained in the following way: equilibrium meets the line at 45º, observing the first intersection from above **c.d.f.** (cumulative distribution function). In general, **c.d.f.** can cross the line three times, twice or once. For values of below σ_e, the first intersection above is in a low point, and it is followed by an intersection from below, and later by another one from above. At critical point σ_e, the two first intersections are combined at a tangent point to the 45º line, and there is a new intersection above. After this point, the only intersection is near 100, and it gradually falls as the probability density gets flatter.
This perturbation –second order change- may correspond to a lower fluctuation in the group composition, or a change of situation that will somehow change the threshold

[81] Mark Granovetter, *op. cit*

distribution. This seemingly insignificant cause in relation with its effect would never be attributed the cause status.
The model clearly leads to sensitivity to initial conditions, two groups with almost identical preferences can generate completely different results.

A dynamical analysis requires a systematic follow-up of the equilibrium stability that follows a given distribution of thresholds, taking into account the variety of influences modifying the distribution of existing thresholds.

According to Granovetter, a fundamental factor when analyzing changing threshold distribution effects is the so-called social structure factor; in fact, mutual influence, since it refers to how a given person influences someone else's behavior, which depends on the relationship they have. For example, friends exert twice as much influence as strangers, assuming that thresholds occur in terms of reaction towards friends. An individual with a 50% threshold in a group of 100 where 48 are rumor transmitters and 52 are not, would not react before a rumor when the social structure is absent. But if 20 out of the 100 group members are friends, and 15 support the rumor, every friend will be counted as two. Instead of perceiving 48 transmitters and 52 non-believers, our individual will perceive [(15 x 2) + (33 x 1)] transmitters who adhere to the rumor, and [(5 x 2) + (47 x 1)] who do not believe it and therefore will not pass it on. This leads to a relation of 63/100 = 0.525 instead of 48/100. The perceived percentage of adherents in the previous time period, which in fact is 52.2%, now exceeds the threshold; the individual will thus adhere to the rumor.
However, if we take the assumption that different levels of friendship produce a different outcome when modifying the equilibrium result of a specific threshold distribution, the analysis becomes unproductive, since even a moderate number of individuals within a given density of friendship generates an almost unlimited number of possible sociometric driven outcomes.

4.5.8 Rumor as Epidemics

In the 50's, the "Revere Project" at the Public Opinion Laboratory, University of Washington, studied the distribution and effects of messages in fliers thrown from airplanes as well as other aspects of data diffusion. Message diffusion via fliers was proportionally higher when they were distributed near closed communities than in open and distant locations. Small cities started to spread information more rapidly than big cities, and usually information was shared with friends and acquaintances. Similar patterns were observed in the Second World War: during rumor diffusion, the level of rumors increased through a relatively low number of well defined paths (networks).
As mentioned in this chapter, the rumor diffusion process can be conceptualized as contagion, i.e. a present state will infect the other, and so on, until the whole population is infected. The rumor on the "insect epidemics" is a good example of how a hysteria contagion can affect the whole population. This case was studied by Kerckhoff, Back, and Miller[82]. The outburst took place in a Southern small textile factory in the summer of 1962. For a week, 62 people were affected by imaginary insect stings. The victims -all women- showed the classic symptoms of hysteria, and most of them were in an operative sector of

[82] Mark Granovetter, *op. cit*

the plant. The imaginary insect first “stung” social isolates, but after some time the epidemic was systematically spread to their circles of friends.
An advantage of this contagion metaphor is that, as certain conditions are known, it is specific enough to build a mathematical model. According to Rosnow[83], Stuart Dodd, and his Revere Project colleagues designed a mathematical formula for message diffusion on the base of exponential or logarithmic functions. Rapoport used the same data in more complex formulas and advanced calculus to apply a mathematical theory of random networks to the understanding of informal communication[84]. The contagion metaphor has also inspired empirical studies suggesting that contagion behavior is often involved in limit reductions derived from the group, i.e. a reduction of inhibitions as to perform an act deemed prohibited by personal ideologies, group rules, or culture.

Other diffusion models are connected with certain background characteristics, as the amount of collective excitement in local population and cultural habits. This idea can lead to the fact that under high excitement conditions, conventional rules that govern communicative behavior are relaxed. In this framework, rumors are wildly spread as epidemics into sub-groups and classes, without being questioned, in view of emotional needs, attitudes, and values of the participants.
Epidemic processes characterize such diverse processes as fire spread, starfish outbreaks, or invasion of exotic plants. In all epidemic processes interactions consist of point-to-point spread: a sick person infects another; one burning tree ignites another; water currents carry starfish larvae from one reef to another; and seeds spread from one site to another. The emergent property is the epidemic itself.

Epidemics can be characterized as invasion by percolation. The term percolation refers to flows through porous media. Invasion by percolation refers to flows that create their own channels through a medium. As with all percolation processes, epidemics display critical behavior for some parameters associated with the process, which exhibits a “phase change”, from non-spread to spread, at some critical value. In this respect epidemics resemble a large class of phenomena, ranging from collapsing sand hills to nuclear chain reactions. For diseases, the critical parameter is the infection rate, which is the probability that one sick individual will infect another. If this infection parameter is lower than the critical value, the epidemic dies out naturally; if it is higher, then the epidemics spreads indefinitely, as shown in the following figures:

[83] Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976).

[84] A. Rapoport, *N-Persons Game Theory,* (University of Michigan Press, 1970) Cited by Mark Granovetter, *op. cit*

a *b* *c*

Spread of epidemics with differing infection rate: a) sub-critical; b) critical; c) super-critical. In the simulation shown here the neighborhood of each cell consists of the four adjacent cells and the infection rate E is the probability that an infected cell will infect each neighbor. For this system E = 0.59.[85]

The critical value somehow corresponds to the concept of threshold since it refers to the level over which the system changes its state. When the population's infection or contagion rate exceeds a certain value there is epidemics; similarly, the rumor will have to exceed the population's average threshold level to expand.

The objective of the epidemic model is to understand and -if possible- control the spread of diseases; when applied to rumor, the objective is to understand the diffusion mechanics.

The model attempts to relate interaction dynamics on the population level, with the basic characteristics of the populations prone to rumor as well as generation, transmission and diffusion processes. As other models, for them to add value, they must have the possibility of being tested; however, the scope for experimental research of rumor dynamics is severely limited due to rumors' high volatility. Therefore, information is frequently non-existent or, in the best case, visibly incomplete.

Basically the purpose of the construction of epidemic models[86] is to find and establish a small set of model components that determine the dynamics, and to describe these as far as possible in terms of simple parameters with clear interpretations, such as the basic reproductive ratio, R_0, (the mean number of rumor communication interactions caused by a transmitter in a wholly susceptible population to accept rumors as true information), and the rumor mean generation gap, π (the time interval between the moment when an individual receives the rumor and passes it on to others).

Three main epidemic stages are usually distinguished: Establishment, Spread, and Persistence. To these we might add Arrival, the question of how infection reaches the population under consideration.

Given that a rumor arrives in a population, the first question is that of Establishment, that is whether it has a chance to proliferate among a sizeable proportion of individuals, rather than just a few of them.

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[85] David G. Green, "Emergent Behavior in Biological Systems". In *Complex Systems – From Biology to Computation* (Amsterdam, IOS Press, 1993).
See http://www.csu.edu.au/complex_systems/green.html

[86] Klaus Dietz, "Some Problems in the Theory of Infectious Disease Transmission and Control" (1995), in Denis Mollison (editor), *Epidemic Models: Their Structure and Relation to Data*. (Cambridge, Cambridge University Press, 1995), Page 7.

The spread of a rumor may be restricted within a "core" group, e.g. organization or social circle, or it may spread in a regular wave-like manner. In the case of spatial waves ("solitons" according to the Chaos Theory) the number of infected individuals grows linearly along time, while in branching diffusion the number of infected individuals grows exponentially. Intermediate rates of growth may be expected in intermediate situations, such as where the population is divided into a hierarchy of mixing groups.

Finally, the conditions for persistence of an infection, whether at a steady level or as a sequence of outbreaks, may be expected to involve other factors. Barlett introduced the idea of critical community size for a given rumor, below which an isolated population cannot sustain the rumor in the long term[87]. This critical community size, N, will depend primarily on the relation between the time scale of the rumor itself (transition time of social perturbation that rumor entails) and that of re-growth of susceptible numbers.
The required population size for persistence depends on the spatial structure, the population connectivity, and rumor parameters. The Procter & Gamble rumor would not have persisted for over 20 years if it had been limited to the Florida state, where it was originally generated.

Perhaps the most basic modeling components are those describing the time history of an individual who likes rumors. From the point of view of the rumor as epidemic, the essential element is its distribution in time and among the communications performed by the "taker", regarding his own time and place of "infection". This can be described in a general manner via an equation describing the number of such interaction over time and location.
One convenient simplification is to assume constant transition rates from the rumor communication reception to the acceptance and availability for re-transmission, and from this phase to the state of extinction, whether because the rumor is reasonably refuted or because the issue in question is no longer relevant for the recipient. An alternative simplification is to assume a fixed "incubation" period (i.e. the time period between the originating fact and the lack of information, and rumor generation) and an instantaneous infectious period (the rumor generates and starts to spread), resulting in a constant generation gap.
These simplifying assumptions will make little or no difference to some aspects of the dynamical model behavior. There are a number of basic formulas where only the mean generation gap or the infectious period is required. Other aspects, however, such as the stability of endemic conditions (some rumors, like Procter & Gamble or President Kennedy assassination, can be considered endemic since they appear on a periodic basis) may depend sensitively on the distribution of the generation gap.

Turning now to the contacts made by an individual, the simplest case is homogeneous mixing, where victims are selected from the whole population probabilistically and with equal likelihood. This is called heterogeneous mixing[88], according to Mollison. On the contrary, homogeneous mixing is when the sender chooses the recipient following a certain profile (e.g. an opinion-leader or a naive individual) or within a special group (a

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[87] M.S. Bartlett, "Measles Periodicity and Community Size" (1957), in Denis Mollison (editor), *Epidemic Models: Their Structure and Relation to Data*. (Cambridge, Cambridge University Press, 1995), Page 9.

[88] Denis Mollison, "The Structure of Epidemic Models", in Denis Mollison (editor), *Epidemic Models: Their Structure and Relation to Data*. (Cambridge, Cambridge University Press, 1995), Pages 17-33.

company, university, or the circle of friends) or a spatial group (a neighborhood), i.e. the recipient is defined either social or geographically. The definition of geographical neighbors takes into account the distance and frequency of communication.
Careful consideration of the probabilities of contact with different possible recipients is of particular importance when the population is divided into groups. Where there is a wide variation in interaction rates, perhaps both within and between groups as in the case of a company, the result of rumor diffusion can depend on the structure of the interaction.
Likewise, when the population is divided into large groups or similar communication networks, as rumor spreading in households through formal channels (as the flier in the case described by Kapferer[89] or the Revere Project), it may be possible to develop hierarchical models, in which the groups are treated as individuals at the higher level of the model, as done by Buckner with multiple interaction networks[90].

An alternative approach to modeling the rumor diffusion process is to look from the disposition's rather than from the transmission's viewpoint, working in terms of the transmission pressure to which an individual is susceptible. This is connected with Granovetter's concept of threshold or critical sensitivity, referring to how critical the individual is towards the discourse, the transmitter, and the alleged source of the rumor.

In their models of artificial societies, Epstein and Axtell analyze social networks based on computerized programs of cellular automata[91]. They present an epidemiology model whose attractiveness is evident for evaluating its networks; it shows similarities with rumor development.

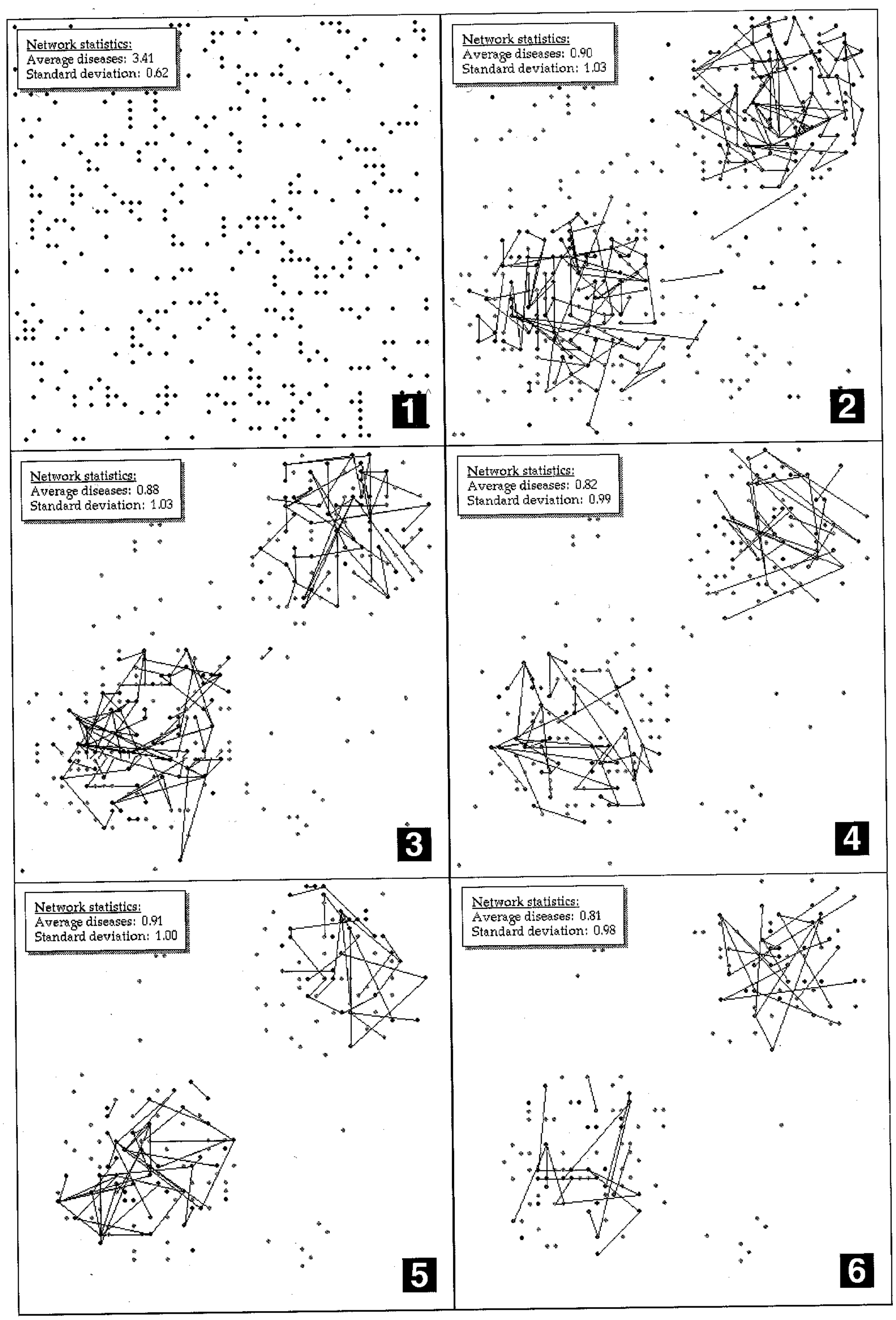
Quoting William McNeill[92], the authors express that there are several reasons to include epidemiology in social sciences and viceversa.
The model development in the following figure is a population's bifocal epidemic, and it shows the dynamical development of contagion networks.

[89] Jean-Noël Kapferer, *Rumors: Uses, Interpretations & Images* (New Brunswick and London, Transaction Publishers, 1990), Pages 34-35

[90] H. Taylor Buckner, "A Theory of Rumor Transmission"., *Public Opinion Quarterly Nº 29* (Chicago, Vol.1, 1965).

[91] Joshua M. Epstein and Robert Axtell, *op. cit.*

[92] W.H. McNeill, *Plagues and People* (Anchor Press/ Doubleday, 1976) in Joshua M. Epstein and Robert Axtell, *op. cit.*



*Epstein and Axtell' model of artificial society for an epidemic where the dynamical system of cellular automata is developed according to the rule **({ G_1}, {M,E})** where: **G_1** defines that in each point of the network the disease develops at 1 per time-interval rate,*

__M__ defines the movement of agents considering: a) each agent analyzes each of the four positions next to its current position (north, south, east and west), b) for free positions, it finds the nearest one; c) it moves to this position; and d) it takes all resources of this position, and
__E__ defines the agent's "immunological response" and "epidemic transmission" combination.

4.6 Rumor Attractors Analysis

4.6.1 Belief Systems as Mind Attractors

Our beliefs are a powerful force in our behavior modeling. They influence our will, our ability to manage the stress derived from strong disruption created by the transition of perturbations in our life, and influence our ability to establish consistent and healthy life patterns. In this sense, they are the source and the limit for our attitudes and behavior. Belief systems are rigid structures of thought in the mind. Religions, ideologies, paradigms, and certain types of mental disorders such as phobias and paranoias are belief systems.
They are basically the foundations of all decision-making process. In this sense, they are as important as letters for word-formation. As words cannot be created without letters, individuals cannot make decisions if they leave their belief system aside.
"Belief" is referred to an actor who expects something to be true. In contrast with theoretical expectations, a belief system should be formed by rules and should have a hierarchical organization. A scientific theory, market prices, love in personal relations, etc, can functionally differentiate from rules in individual or collective systems. The difference between perception and reflection -discretional to actors- and observable communications in a network is a prerequisite to understand the meaning of "truth" in social communications.
Although sciences have made a big effort in studying belief systems, they have analyzed them as static construct, while in fact they are basically dynamical and complex mind systems. On the other hand, the change of belief systems along time has been considered an important topic of study lately; however, as field of research, it is emerging only recently.
Our thesis is that certain systems are powerful rumor attractors. Prejudices and conspiracy theories are two clear examples of belief systems that function as rumor attractors.

There is a holistic unit that involves the mind, the brain, the behavior and the environment: none of them can be understood as a separate entity. Its interactive and complex processes comprise an organic entity, i.e. the mind is a dynamical system.
According to Abraham[93], the mind's complex patterns are conceived to show and integrate different attractors as well as other characteristics of dynamical systems. Despite the impossibility of a thorough description, some of their properties can be analyzed from the emerging hypothesis of the theory of complex dynamical systems: what could constitute a theorem for mathematics, for psychology is just a hypothesis.

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[93] *Frederik Davis Abraham, "Dynamics, Bifurcation, Self-Organization, Chaos, Mind, Conflict, Insensitivity to Initial Conditions, Time, Unification, Diversity, Free Will, and Social Responsibility". In: Robin Robertson and Allan Combs,* Chaos Theory in Psychology and the Life Sciences*. (New Jersey, Lawrence Erlbaum Associates Publishers. 1995), Page 158.*

From this perspective, for example, the memory -chaotic attractor- demands time to express itself by definition... how long does the brain take to process this attractor and how long does it need to understand it? This issue brought about several discussions, in part to emphasize the dynamical systems context, and also-more strongly- to relate it to the discrimination problem between attractors that represent different processes of the mind, such as specific memories or belief systems.
It is tempting to say “states of the mind” instead of “processes of the mind”, but for the purposes of the study of dynamical systems, “state” is a technical term that represents a system only at a given instant. However, according to Abraham, the properties of attraction, the complex general pattern, the attractor, represent a process of the mind. It is not as if it were a specific trajectory, but any trajectory from this attractor. The exact starting time and location of a thought flow, as well as its precise space-temporal location are irrelevant. In fact, nobody up to now has specified neither an attractor for a given memory, nor any other process of the mind, nor what the other attractors must be like for identification purposes.

Moran explains that psychoanalytical models of the mind can be viewed as non-linear dynamical systems. According to him, one can find patterns in mental processes that repeat themselves continuously, yet not in a precise periodic way but as strange attractors. Moran -in his role of psychoanalyst- compares the concept of strange attractor with the patient’s fixed collection of unconscious fantasies about himself and his environment. In psychoanalytic observation and research, no matter how complex the behavior of a patient, this collection of unconscious fantasies always turns out to play a fundamental role. He believes that the strange attractor is very complex. It is possible that only a small part of the attractor is very active, i.e. one small part of the attractor is frequently visited by the solutions of the dynamical system, while the other parts are being neglected. Moran exemplifies this with the example of a paranoid state of mind where the unconscious dynamics is dominated by a part of the collection of unconscious fantasies[94].

The strange attractor is a determining force for the activities of the mind; as in any chaotic system, an individual’s behavior is unpredictable, but the presence of a specific strange attractor -a collection of typical unconscious fantasies for a specific individual- limits unpredictability. Arbitrary behavior is not expected from a “normal” individual since the structure of his strange attractor limits his erratic or seemingly random behavior.

Benjamin Goertzel, a young American researcher -degree in psychology and a Ph D in Mathematics, author of several books on the mathematics of the mind- says that before one settles on a fixed system of beliefs, one’s opinions may wander all over the spectrum, following no apparent pattern. But once one arrives at a belief system, one’s opinions are unlikely to vary from a narrow range. However, if one is to declare that belief systems are attractors, Goertzel wonders, one must specify: attractors of what dynamical system? To say “attractors of the brain” is obvious but inadequate: the brain presents us with a system of billions or trillions of coupled non-linear equations, which current methods are incapable of analyzing even on a quantitative level. If belief systems are to be viewed usefully as attractors, the relevant dynamical iteration must exist on a higher level than that of individual neurons.

[94] Michael G. Moran, “Chaos Theory and Psychoanalysis: the Fluid Nature of Mind”. (Revista. *Psycho-Anal*. Nº 18, 1991).

He argues that, in order to make headway toward an understanding of psychodynamics, we must consider the dynamics of interacting mental processes or neural maps. An equation for the evolution of mental processes is proposed, and it is suggested that the mind may be viewed as residing in strange attractors of this equation. Relating these formal ideas to real-world psychology supposes that a specific belief may be seen as an attractor of this "cognitive equation of motion"[95].

4.6.2 Anxiety and Search for Enemies

As seen before, uncertainty is the main triggering factor for rumors, besides the importance of the topic. What follows is how anxiety -resulting from uncertainty and fear- can generate an attractor in the rumor generation and diffusion process.
An articulate and mature individual is the one who can interact with other people and satisfy his needs according to ways that are acceptable for himself and the society. However, the environment is not always benign and in order to survive, individuals develop techniques to face danger. A person is aware of the danger of the feeling of anxiety. It is especially meaningful among all the other unpleasant feelings because provokes automatic organic responses, as pulse acceleration or breathlessness.
Anxiety may be caused by an external dangerous situation or an internal perception of danger. Either way, the individual feels threatened and tries to set himself free from such threat. If the danger is external, he can manage it by avoiding it, controlling it or overcoming it. In fact, physiological changes such as accelerated pulse are autonomous mechanisms to facilitate the physical activity of attack or escape. However, the situation is different when anxiety is caused by a perception of danger originated in the individual's internal world. Everybody develops techniques to manage this neurotic anxiety: they are defense of the ego or self defense mechanisms.
The most common defense against this internal anxiety is called projection, by which the feeling expressed by the phrase "I hate you" becomes, through projection, an anxiety-reducing feeling: "you hate me". As you can see, the subject and object have switched, and as the threat is now externalized, action can be taken. "If you remember that in general terms, the **self** is better prepared by experience and practice to face external dangers, it is easy to see why projection prevails as a defense mechanism. When creating a "real" enemy, the person feels prepared to take the control of the situation. For example, he can destroy or try to destroy his enemy: this will allow him to satisfy his aggressive impulses without incurring in feelings of shame. Therefore, projection is probably the most efficient defense mechanism"[96].

Yet, this type of defense does not offer a permanent solution since the person stills feels danger and nothing is solved. In terms of mental energy, projection implies the transfer of a catexia, i.e. an energy concentration in a certain person, thing or idea. As long as this happens, contact with reality is lost. The feeling of anxiety is temporarily reduced, but the

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[95] Benjamin N. Goertzel, *The Structure of Intelligence: A New Mathematical Model of Mind*. (New York, Springer-Verlag. 1993).

[96] C.S. Hall and G. Lindzey, "The Relevance of Freudian Psychology and Related Viewpoints for the Social Sciences". In: G. Linzey and E. Aronson, *Handbook of Social Psychology* (Massachusets, Reading. 1968).

consequence is that mental or physical energy is used to attack “a fake person or group”. The source of anxiety is still concentrated within the mental system, although the psychical and physical resources have become exhausted in the process[97].
Prejudices and conspiracy theories are two classic examples of the search for reduction of anxiety reduction to the extent they let us find the guilty parties on which we can project our own problems, dissatisfaction or frustrations.
The amount of projection depends on two factors. One of them is one aspect of the personality: the personal tendency to use this defense mechanism. For example, in a group **x**, where structure and organization are reduced to the minimum, individuals start to understand their own tendencies and to react before anxieties via projection. However, this knowledge of the self cannot ensure per se that this person will reduce by projecting his hostility to the minimum. The other factor affecting projection is the individual’s situation. The individual’s social structure builds an environment that fosters or reduces anxiety and, therefore, an individual is likely to feel threatened and thus resort to projection. The most threatening the perception of the external situation, the more likely it is that the person resorts to projection.

4.6.3 Prejudices as Attractors

Black or white; homosexual or straight; rich or poor; corrupt or honest; a slut or hard to get; a winner or a loser; a progressist or a fascist; short or tall; fat or slim; miserable or happy; old or young; Jewish or Turkish. Prejudice draws the line; it is the way to say what we do not want to be, and what we are. It supports genocide, provokes war, leads to fanaticism and suicide. It is a false argument that both defines and condemns us. Prejudice makes us judge the others to avoid being judged. It is the paradox of morality without morality that thrives in fear. Rumors are the fertile soil for the boosting of prejudices. In fact, rumors and prejudices share similarities. One of the widest spread prejudices is that the more important the people involved in an event, the more complex the reasons of the event itself. This automatically leads to the development of the conspiracy theory discussed later. Doubtful deaths such as President Kennedy’s, or the attack to the Israel Embassy in Buenos Aires, or the Roswell case [98] are favorite topics chosen by conspiracy theorists.
Prejudices are not only powerful rumor attractors but they are the ideal culture broth for their generation.
According to Ernst von Glaserfeldt, individuals do not receive knowledge in a passive manner through their senses or via communication. The function of cognition is adaptative, and makes the individual organize his empirical world, rather than discover an objective ontological reality.
According to epistemology, during the “instruction” process on the image of reality, the individual must somehow receive the environment’s information, i.e., he must be “instructed”. This science considers that our senses work like a camera that projects an

[97] Robert De Board, *op. cit.*

[98] This refers to the alleged fall of an extraterrestrial spacecraft in the New Mexico desert in 1947 and the autopsy on two alien bodies performed by the US Army, episode which was later strongly denied and kept secret by the US Government.

image in our brain of the world as it really is; this image is like a map and its code is somehow different to the structure of the reality "out there".
This perspective carries a series of conceptual problems since it ignores the world's infinite complexity. Constructivism, as opposed to classic epistemology, states that knowledge does not work that way. For this approach it is evident that people actively generate a model potential and the external world only fits and reinforces these models while others are eliminated by default. The purpose of the "construction" of reality is twofold: a) the individual wants to be in control of what he perceives to eliminate any deviation or perturbation from the perspective of his own objectives; and b) this control requires a model of the "thing" to be controlled. This model will only include all those aspects relevant to the individual's objectives and actions. In a sense, the individual is not interested in the "thing" to be controlled itself; he is interested in compensating the perturbations produced by it on the objective to be achieved and adapting it to the changing circumstances. These models are the prejudices.

The most doubtful prejudice is assuming that we can live without prejudices. This is impossible, and this holds valid for any field of action. In any case, the matter is: to what extent prejudices take place, and most importantly, what consequences they have. That is to say, if we are aware of them and how.
Possession and usage of prejudices is not tied either to specific personality traits or to educational, cultural or socioeconomic levels. According to several research works, the level of prejudice is a constant in all individuals. The difference is that both the field of knowledge and opinion issues, subjected to prejudice, are different[99].
Life and everyday behavior constitute an ongoing learning process. This learning -conscious or unconscious, willing or under pressure- leads to a world made up by knowledge and opinions. The psychological structure of our reality responds to the development of a geography, which gains in accuracy with time. In this sense, stable reference frameworks are the pre-requisite for reasonable behavior.
When certain topics or relations are new for an individual, he will deny them or seek an explanation on the basis of the background of what he has heard or read, i.e. what he has learnt, always trying to find an explicit point of reference. The probable consequence is that, in reference to the same issue, different people will choose different points of reference that will produce different experiences and will determine heterogeneous assessments.
When we vehemently and repeatedly defend a certain viewpoint, we are operating a stabilization mechanism that dominates the naive behavior so that reflection no longer takes place or, as is frequently the case, when the everyday behavior has to operate economically, we are not even prepared to reflect it on our acts. Our mind is attracted to an attractor. This is the point of maximum human contradiction: as we are condemned to live with a wide spectrum of issues we take for granted, we learn to love them when we lose them. What produces stability and confidence in the environment, can at the same time be a barrier that hinders intellectual or material development and can be a triggering factor of possible insecurity attitudes of and therefore equivocal behavior. People are frequently aware of this only when they are confronted with the consequences.

Psychology considers prejudices as pseudo knowledge that lead to naive behavior. The German philosopher E. Rothacker says: "we live in a world of images, a world we are not

[99] Reinhold Bergler, *Vorurteile erkennen, verstehen, korrigieren*. (Köln, Deutsches Institut Verlag GmbH. 1976).

willing to abandon. I insist that all our big decisions occur in a naive real world. This world lived with ingenuousness is the real background and is strongly related to the concrete man."[100]

In a survey intended to establish the attitude of Americans towards various ethnic groups - published in the New York Times and reproduced in Página 12, Buenos Aires on April 18, 1995 - a non-existing social group, called "wiseans" was included to evaluate the level of prejudice, unfounded suspicions, and ignorance in the American population. Although most of the survey answerers did not give an opinion on the fictitious group, 40 % did respond. They were rated low, with a 4.12 on a scale of 9, below Greeks, South Africans, and Koreans, but above Guatemaltecan, Iranians, and Gypsies. Respondents for whom wiseans were in a better position than gypsies, thought that wiseans were responsible for several historical evils, e.g. unemployment in several areas of the country.

A world lived with ingenuousness is a universal property of the human being, regardless of past or present privileges or instruction. The "images" resulting from this process are always conditioned by our emotions and are therefore subject to binary judgement either positively or negatively.

People still love their prejudices because they make existence in their environment easier and because they are the basis and requirement for self-sufficiency. In his so-called naive psychology, F. Heider makes three assumptions[101]:

1- The only possibility to understand the social behavior of the human being is to know how he perceives his social environment.
2- Man tends to forecast the development of his environment and to try to control it at the same time.
3- There is no basic difference between the way to perceive objects, things, and the way to perceive people. The difficulty to forecast resides in that a concrete attitude corresponds to a specific characteristic of the personality, according to the law of probability.

Forecasting behavior supposes a functional link of events. Thus, it can be said that lighting bolt will be followed by thunder. Man learns the interrelation of cause and effect at an early age. Therefore, Heider concludes that people perceive behavior as a process starting from a cause, i.e. behavior is caused. The only distinction to be made is as to the origin of the cause, either external or internal.

In this sense, humans self-conceive themselves as "cause agents"; this leads us to the unrestricted desire to determine and control our own behavior. This experience is projected to the behavior of others, i.e. we generalize and attribute our own living relations to the rest in their subjective combination of cause and effect. The concrete result is that each individual is constantly seeking the cause, the reason for the behavior of the others in order to forecast it and thus control it. This clearly derives in the fact that naive behavior is based on judgements whose database is deficient, i.e. based on prejudices. Thus, prejudices form a belief system that is useful to orient and regulate our behavior.

[100] E. Rothacker, *Probleme der Kulturanthropologie*. (Bonn, 1848). Cited by Reinhold Bergler, *Vorurteile erkennen, verstehen, korrigieren*. (Köln, Deutsches Institut Verlag GmbH. 1976).

[101] Fritz Heider, On Perception, Event Structure, and the Psychological Environment (Selected Papers. 1959).

It is a fact that all areas in our environment about which we know very little and about which we have had no option but to be profane expand day by day. On the one hand, the scope of our own ignorance increases disproportionally compared to the increasing bulk of accessible knowledge. In other words, the objective knowledge more and more grows apart from our own level of information. This is a misfortune in itself; however, to make matters worse people generally and systematically deny their own level of ignorance. When faced with an important event, people feel the need to know all the details; if they are deprived of data, anxiety takes hold of them. Uncertainty generates anxiety, and increasing anxiety makes people prone to believing anything. It is culture broth for rumor. When a rumor finally starts circulating and its content coincides with our prejudices, the level of credibility we assign to it is much higher since as it is shared we agree that “it is believable because it must be true”.

The “black holes” of our knowledge, which we obviously do not acknowledge nor admit, always find substitute knowledge. This pseudo knowledge is articulated in the shape of opinions, formulas and ideologies that we employ as if they had been the result of our own knowledge.

The mechanism generating everyday opinions and prejudices is triggered by conscious perception, yet sometimes in the unconscious perception and in black holes. Black holes automatically derive in “labeling”, since empty spaces cannot be left empty because they bring insecurity and instability to our lives.

Insecurity makes the individual seek stability, according to what Mc Guire calls “basic need to know”[102]. This basic need to know can generate rumor and it is essential for the individual to re-obtain a reference system for his everyday behavior. This is defined by Walter Lippmann, in his work Wege und Abwege der Psychologie (Ways and Deviations in Psychology): “in most of the cases we define before we see, and we do not see until we have defined”[103].

From the surrounding multiphase world we generally take what has already been defined by culture and we perceive it in the stereotyped manner it is transmitted to us[104]. When there is no reference, the empty spaces of knowledge can have such unconscious effect that we are not aware of its “filling”.

These spaces can also appear in the conscience as data deficit and trigger out questions. The target of the questionnaire (a person or a formal communication system)– whether addressed directly or indirectly- is forced to communicate. Should he refuse to answer, the unanswered questions will be tackled by other sources because, as seen before, if

[102] W.J. Mc Guire, *The Nature of Attitude Change*. In: *The Handbook of Social Psychology*. (Massachusetts, 1969).

[103] Walter Lippmann, *Wege und Abwege der Psychologie*. (Hamburg, 1956).

[104] According to Piwinger and Niehüser, the origin of our knowledge about this world is very much restricted because it is centered around direct personal experience: “ ...anything human beings do, not based on immediate and certain knowledge, but on images constructed by himself or given to him ...”
Piwinger, Manfred and Niehüser, Wolfgang: Was geht nur in den Köpfen der Leute vor? Über die Bedeutung des ersten Eindrucks und die Rolle von Vorurteilen. In: Piwinger, Manfred (edit.), Stimmungen, Skandale, Vorurteile, (Institut für Medienentwicklung und Kommunikation GmbH in der Verlagsgruppe FAZ, Frankfurt, 1997. Page 205).

during forced psychological communication condition, concrete, credible and comprehensible information is rejected, it is replaced by some other data. In other words, and quoting Bergler: "the market always offers something to fill the empty spaces of knowledge"[105].

The growing complexity of the world we live in, aggravated by the lack of disposition and ability to transmit data immediately via adequate means, in a concrete and comprehensible manner, accounts for the increasing demand for different and various ideologies characterized by their extreme simplification and explicit quality. Ideologies do not entail either the existence of complex interrelation processes or the diversity of complex social structures. They are governed by naive judgement laws born from impressions; they divide the world in dichotomic categories, e.g. good-bad and positive-negative, to later label the scapegoat. It is obvious that our own world is the good one. To reach this "ideal" state where things are known, we correct the situation with patience and tolerance, or with impatience and violence, depending on the ideology in question.

To summarize: opinions and prejudices are substitute products for our lack of knowledge and they are the result of simplification processes that enable us both to see what is going on around us and to justify our behavior.

4.6.4 Conspiracy Theory as Strange Attractor

A celebrity dies in a car crash; a commuter plane explodes minutes after takeoff; another plane carrying businessmen and government officials crashes overseas; a member of the administration commits suicide; drugs flood the inner cities; a drugs for guns for hostages scheme conducted by the government is exposed; a fatal diseases ravages first one community, then progresses into others; political, religious and cultural leaders are assassinated; cults commit murder and suicide; mysterious sightings are made in the skies; mysterious objects are reportedly found at a crash site in a desert; an entire area is cordoned off by the government, while its very existence is denied.

Official investigations are done by the proper authorities, official reports appear in the media, and official conclusions are drawn and presented. Many accept the official version; others do not. Questions remain. Those questions are raised and voiced, take hold with others, then spread and circulate, forming rumors, which become anecdotes. These anecdotes form the basis of more complex narratives, which reflect long held and deeply felt beliefs. These narratives influence and shape the behaviors, actions and attitudes of those who come to believe them.

These events seem to have nothing in common, except that they are public tragedies. However, they share other two traits. On the one hand, they are all actual events that confirm a huge number of other facts generated in the minds of individuals that build what is commonly called conspiracy theories, and on the other hand, they constitute a recurrent and globalized historical reservoir of rumors: a powerful attractor.

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[105] Reinhold Bergler, *op. cit.*

The word conspire comes from the Latin conspirare--com (with) + spirare (to breathe)--meaning to breathe together. Conspiracies are generally understood to be covert plots by groups scheming to accomplish a specific goal. The goal may be legal or illegal, but the word implies acts that are in their nature subversive. This connotation carries over to conspiracy theories as well. Conspiracy theories, in part, are explanatory narratives. They account for the recurrent public traumas that seem to haunt society. Those who dare to suggest that political or historical events have been directly influenced by the clandestine actions of powerful elites, however, are often dismissed as delusional, superstitious, obsessed, hysterical, even paranoid.

In his work The Open Society and Its Enemies[106], Karl Popper defined the conspiracy theory of society as follows: "It is the view that an explanation of a social phenomenon consists in the discovery of the men or groups who are interested in the occurrence of this phenomenon (sometimes it is a hidden interest which has first to be revealed) and who have planned and conspired to bring it about".

Koenig has devoted his research on rumor to conspiracies; however, his definition is restrictive since he links conspiracy rumors only to arguments related to political, religious, and ideological movements. Conspiracy rumors are obviously connected with other events of magnitude whose result -often tragic- has not been completely clarified; or if so, their resolution is ambiguous or not wholly convincing for most of the public opinion and thus produces uncertainty, anxiety, and fear[107].

It is in the United States in particular, more than in other countries, where the conspiracy mentality and popular beliefs are highly developed and manifested as a mind attractor, and therefore conspiracy beliefs should be understood in terms of the two extremes given to this meaning in U.S.: collective “paranoia” of rightist extremists (according to Richard Hofstadter’s psychological model developed in the 50’s) or undereducated irrationality. In this sense, conspiracy theory or “conspiracism” cannot obviously be regarded as a marginal phenomenon of psychologically perturbed groups. The growth of the collective dimension of this “paranoia” -starting in the 60’s- suggests that conspiracy beliefs can be the symptom instead of the illness[108].

The culture of “secrets” developed mainly in Anglo-Saxon countries has originated, particularly in the last decades, a culture of conspiracy beliefs, supported by cases such as the Kennedy brothers’ assassination, Watergate or Iran-Contras, among others, whose revelations and confirmations (specially in the last two cases) have confirmed that conspiracies are a fact.
Popular imagination about alleged complots and conspiracies are limitless. The postmodern imagery on conspiracies is a hyper-real communication mode, it thus becomes a popular attempt to

[106] Karl Popper, *The Open Society and its Enemies.* (USA, Princeton University Press, 1966).

[107] Unlike the traditional Psychological and functional approaches, which take rumors as spontaneous transactions, the conspiracy model envisions rumors as objects of manipulation or artificially controlled instruments, as parts of an organized effort (...) We come to the conclusion that the conspiracy approach does not provide us with a truly valid explanation on why rumors are generated.
Terry Ann Knopf, *Rumors, Race and Riots* (New Jersey, Transaction Books, 1975), page 97

[108] On the meaning of paranoia and memory dynamics, see Ricardo Pardal, “Notes on Paranoia”, In Spanish in: *ALCMEON (Argentine Magazine on Neuropsychiatric Clinical Studies)* (Vol 2, Nº2, 1992), Page 206-216

re-adapt and re-determine meanings by transforming “secret” information into knowledge available to the ordinary man. On the other hand, the popularity of conspiracy beliefs shows the collapse of the distinction between literal and metaphoric, fact and fiction, paranoia and persecution, diagnosis and symptom, trivial and substantial; i.e. what is likely and what is not.

Conspiracy theories, transmitted basically through rumors are based on the belief system that states that a group of powerful puppeteers behind the stage secretly control the world’s events, while the man in the street -powerless before conspiracy- at least has the advantage of guessing it.
As regards fiction, conspiracy theory is fascinating. The problem is that its supporters project their fiction onto others, their families, groups and real life organizations, and to whom they try to persuade about conspiracy using all available arguments.
In general, an alleged conspiracy is difficult to disprove because, after all, who has the political and economical connections to affirm that there is no conspiracy? Those who disagree will face the difficult dilemma of proving that the content of the “conspiracist” does not exist.

Merton has made an important contribution to the understanding of how the specific types of social structure produce deviated behavior. Deviation is regarded as a social emergent rather than a psychopathological or idiosyncratic problem. Quoting Merton, “socially deviated behavior and conforming behavior, as that of conspiracy paranoids result from the social structure” [109].
Merton highlights that deviated behavior tends to occur in a culture dominated by success, while at the same time legitimate means to achieving it are unavailable for a sector of the population, which is the case in the USA. Consequently, individuals in a disadvantageous condition in the social structure and who cannot effectively compete for cultural targets, try to seek new means. Although Merton basically refers to criminality and ideological violence, the same can hold true for socially frustrated groups, who see power conspiracies causing a damage to them everywhere[110].

Popular culture is the major distributor of conspiracy theories to the general public. Unlike the true believers of various conspiracies who conduct their own research, form communities and exchange information, mass media audiences are passive bearers and come to their knowledge of conspiracies out of awareness.

As the response to the death of Diana Spencer demonstrates, the impulse to ascribe tragedies to the interference of outside agencies appears to be a widespread occurrence. Conspiracy theories demonstrate that conspiratorial thinking is a normal, if not normative, human response to traumatic events. Conspiracies are generated from all points of the ideological spectrum, and conspiratorial thought is found at all levels of society. Marginalized groups pass on stories of the hidden motives of small, powerful elites aligned against them. Politicians gather followers by disclosing them. Talk radio hosts speculate about them. Businessmen expound upon them. People discuss them everyday. Conspiracy theories provide narrative proof that conspiratorial thinking is a normative, if not normal, response to human events. However, the very idea of conspiracy conspires against open serious discussion of the phenomenon today, not to mention any type of objective scholarly inquiry.

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[109] Robert K. Merton, *Social Theories and Structures* (In Spanish: México, Fondo de Cultura Económica. 1964).

[110] According to Koenig, there seems to be a connection between conspiracy theory and anxiety: “There is reason to believe that people preoccupied with a fear of a hidden conspiracy are also high in general anxiety. If we are to understand conspiracy rumors of the commercial type, however, we have to understand where these fears come from. Although the allegations may seem baseless, they all have reasons.
Koenig, Frederick: *Rumor in the Marketplace. The Social Psychology of Commercial Hearsay.* (Auburn House Publishing Company, Massachusetts, 1985. Page 63).

The question that arises is why have conspiracy theories seem to have become so prevalent at this time. Jonathan Vankin and John Whalen[111] attribute their ubiquity to the easy access that people have to the internet, access that is often the source of moral panics used to justify governmental attempts to regulate the web. Before computers were widely available, conspiracy theorists circulated their beliefs by word of mouth, in underground broadcasts, alternative presses, and the circulation of unpublished Xeroxed written works and documents. These narratives have been circulating within a extensive information underground channel for generations. The origin of the underground channel is precisely the fact that the open expression of conspiracy has been unacceptable to the society.

The emergence of new information technologies presents a challenge to society in every sense of the word, the most obvious being challenges to the status quo. The internet, potentially, can merge informational worlds. It gives people access to information that they have not had before, and being a more "egalitarian" form of interaction, it can destabilize social hierarchies.

The Internet began as a network for academics, scientists and government officials, and then rapidly began to be used by anyone with access to a computer. The proliferation of the personal computer made the net increasingly attractive to commercial business, which in turn help to open it up for everyday use. And because it was an unregulated media, people formed communal networks dedicated to their interests. These interests could be centered around entertainment (television, film, books, music), politics, education, art, and previously taboo subjects such as sex or conspiracy theories. The expansion of the Internet provided then another channel of communication for conspiracy theories, a freer and especially faster and safer one.

The speed with which the Diana conspiracies spread was astonishing, even taking the considerable impact of the increasingly ubiquitous computer networks into account. This impact is primarily responsible for the myriad forms that the almost instantaneous responses to the events of her death took. Lamentations, shrines, rumors, reminiscences, jokes, even shrines arose immediately. So did conspiracy theories, a phenomenon that would have been inconceivable ten, even five years ago, when the diffusion of information was (relatively) slower and the open expression of conspiracy theories was (socially) prohibited.
Both the case of Diana and another recent tragedy described in chapter 2, the crash of TWA Flight 800 are clear evidence of this instantaneous feature. It took three months, from July 17, 1996 (date of the plane accident) until October 15, 1996 before the various accounts of the crash broke onto the web as fully formed conspiracy theories. In the case of the Paris car crash (on August 31st, 1997), dozens of rumors began to appear within a matter of days.
Long time conspiracy researchers Jonathan Vankin and John Whalen, authors of The Sixty Greatest Conspiracies of All Time, observed on its companion website: (http://www.conspire.com/curren33.html) "We received our first e-mail on the subject – suggesting that Di was killed by 'MI-5' " (sic) -- within minutes (yeah, that's right, minutes) of the initial news bulletins. Between August 31st until her funeral on September 6th, speculations about how and why Diana Spencer died appeared and spread exponentially through cyberspace like a virus".

On Tuesday, September 2, as the steady, incessant, universal coverage of Diana Spencer's death swells, a story in The Philadelphia Inquirer describes how rapidly groups dedicated to her formed on the worldwide web. The account includes reports of conspiracy theories beginning to circulate through the internet. "Overnight, Diana's death was deemed mysterious enough to warrant its own conspiracy-theory newsgroup, alt.conspiracy.princess-diana putting her in the company of the Rev. Dr. Martin Luther King Jr., John F. Kennedy and Area 51, all of which are dissected regularly on-line".
After the assassination of John Kennedy in 1963, an interesting item began to circulate orally and in print media. Certain correspondences between Kennedy and another

[111] Jonathan Vankin and John Wahlen, *Dodi, Dodi, Doh: Conspiracy Theories of Di's Death Prove to be Boring!* (http://www.conspire.com/current33.html.) September 10th, 1997.

murdered president were found: Lincoln was elected president in 1860, Kennedy in 1960. Their names both consist of seven letters. Lincoln had a secretary named Kennedy and Kennedy had one named Lincoln. Lincoln and Kennedy were assassinated by John Wilkes Booth and (allegedly) Lee Harvey Oswald, respectively, men who went by three names and who advocated unpopular political positions. Booth shot Lincoln in a theater and fled to a warehouse; Oswald shot Kennedy from a warehouse and fled to a theater". Mathematician John Allen Paulos used a version of this item in A Mathematician Reads the Newspaper to demonstrate his general thesis; that the mathematical ignorance of the general public contributes to general social ignorance and gullibility on a variety of subjects. Paulos applies mathematical knowledge to the ways that information is conveyed in newspapers and provides a typical example of the common skepticism that the very idea of conspiracy engenders: “There are so many ways in which events, organizations, and we ourselves may be linked that it's almost impossible to believe in the significance of all of them. Yet many do, sometimes arguing that the probability of this or that coincidence is so low that it must mean something. Such people fail to realize that though it is unlikely that any particular sequence of events specified beforehand will occur, there is a high probability that some remarkable sequence will be observed subsequently. This is especially so when I inundated with so much decontextualized information”.

For Paulos, conspiracy theories are outside the bounds of acceptable thought and are evidence of irrational, unsophisticated minds. This is understandable. For a mathematician, belief in conspiracy must represent the antithesis of scientific thought.

However, people who come to believe in conspiracies are not necessarily "paranoids" either clinically or as the term is popularly used. They are people who led quiet, ordinary lives, who had an experience that "illuminated" them. It could have been an assassination, a plane crash, the sighting of a UFO, or the threat of a foreign power imposing its ideology on the world. As the butterfly attractor, in their minds there is a sudden shift, a jump from one level to another, like a light switch being turned on. An abrupt, discontinuous transition from one state of understanding to another occurs--we "get it".

Instead of generating and validating hypotheses, conspiracy theorists haphazardly string together coincidence, clumsily arriving at preconceived notions: "In the throes of obsession, the conspiracy theorist searches not for arbitrary coincidences but only for those that support his beliefs--and because of the myriad connections among items in the paper, he is almost always successful"[112].

Richard Hofstadter's The Paranoid Style in American Politics set the standard for modern academic analyses of conspiracy theories which, as we have seen, is consistently and decidedly anti-conspiratorial. What is often overlooked by those who casually invoke Hofstadter is that he is analyzing a specific style of American political thought, not the truth or falsity of conspiracy theories. Hofstadter takes care to distinguish between what he termed the paranoid style and clinical paranoia: "... the clinical paranoid sees the hostile and conspiratorial world in which he feels himself to be living as directed specifically against him; whereas the spokesman of the paranoid style finds it directed against a nation, a culture, a way of life whose fate affects not himself alone but millions of others"[113].

[112] John Allen Paulos, *A Mathematician Reads the Newspaper* (In Spanish: Barcelona, Tusquet Editors, 1995) Page 49-50.

[113] Richard Hofstadter, *The Paranoid Style in America’s Politics*. In: *The Paranoid Style in America’s Politics and other Essays* (New York, Knopf editor, 1966) Page 4

There certainly are conspiracy theories that are preposterous, nonsensical, wrong, even dangerous, but this does not justify leaving the phenomenon aside and rule out conspiracies as if they did not exist. The problem as we suggested is that certain people tend to justify with actual complots their beliefs that conspiracies are everywhere.

4.6.4.1 Jane's Conspirational Belief System

According to Goertzel, the conspirational belief system is an attractor, and the real case he has chosen to illustrate this is extremely appropriate to show that conspiracy theories are a powerful attractor of rumors[114]. When describing Jane' s conspiracy beliefs, Goertzel lists seven key beliefs and he says that these beliefs outline a strange attractor. He explores the relation between the irrationality of this belief system and its dynamical properties to conclude that there is a tendency to irrationality when a mind's sub-group persists because it is an attractor rather than because of its interactions with the rest of the mind.

The model is based on a real woman, Jane, suffering from paranoid delusion.

Goertzel says that Jane almost never ate because she believed that "all her food" was poisoned. She had a history of bulimia, and she has lost 25 pounds in the last month and a half; she was 5foot 1' and weighed 85 pounds. She believed that any food she bought in a store or a restaurant or receives at the home of a friend had been poisoned. When asked who had done the poisoning, she generally either answered or said, accusingly, You know! She had recurrent leg pains, which she ascribed to food poisoning. Furthermore, she believed that the same people who had been poisoning her food were following her everywhere she went, even across distances of thousands of miles. When asked how she could tell that people followed her, she either said "I'm no stupid" or explained that they gave her subtle hints, such as wearing the same color clothing she wore. When she saw someone wearing the same color clothing she was wearing, she often assumed the person was a "follower", and sometimes confronted the person angrily. She had recently had a number of serious problems with the administration of the college that she attended, and she believed that this had been caused by the influence of the same people who had been poisoning her food and following her.

To give a partial list, she believed that this conspiracy involved: a) a self-help group that she joined several years ago, while attending a college in a different part of the country, for help with her eating problems; b) professors at this school, from which she was suspended and that she subsequently left; and c) one of her good friends from high school.

Her belief system was impressively resistant to argument. If you suggested that perhaps food made her ill because her long-term and short-term eating problems had altered her digestive system for the worse, she concluded that you were stupid or part of the conspiracy. When reminded that 5 years ago doctors had warned her that her leg problem would get worse unless she stopped running and otherwise putting extreme pressure on it, and suggest that perhaps her leg would be better if she stopped working as a dancer, she would conclude that it was stupid or part or the conspiracy. She had been suggested that her problems at school may have been due partly to the fact that she was convinced that

[114] Benjamin Goertzel, *Belief Systems as Attractor*, en Robin Robertson y Allan Combs (edit.): *Chaos Theory in Psychology and the Life Sciences*. (New Jersey, Lawrence Erlbaum Associates Publishers, 1995). Page 123-134.

people were conspiring against her and consequently acted toward them in a hostile manner, she would conclude that it was stupid or part of the conspiracy.

In order to show that Jane's belief system is an attractor for this dynamic, Goertzel says it suffices to show that each element of the belief system is a pattern among other elements of the system and is potentially producible by other elements of the system. Consider, for example, the following beliefs:
C0: There is a group conspiring against me.
C1: My food is poisoned by the conspiracy.
C2: My friends and co-workers are part of the conspiracy.
C3: My leg pain is caused by the conspiracy.
C4: My food tastes bad.
C5: My friends and co-workers are being unpleasant to me.
C6: My leg is in extreme pain.

We should also take into account that Goertzel's equation says:
1. Let all processes that are "connected" to one another act on one another.
2. Take all patterns that were recognized in other processes during Step 1; let these patterns be the new set of processes, and return to Step 1. An attractor for this dynamic is then a set of processes X with the property that each element of the set is:

a) produced by the interaction of some elements of X, or
b) a pattern in the set of entities produced by the interactions of the elements of X.

It will be implicitly assumed that each of these beliefs is stored redundantly in the brain; that each one is contained in a number of different "neural maps" or "mental processes". Thus, when it is said that C0, C1, C2, and C6 "combine to produce C3", this should be interpreted to mean that a certain percentage of time, when these four beliefs come together, the belief process C3 is the result. Furthermore, it must be remembered that each of the brief statements listed above next to the labels C1 is only a shorthand way of referring to what is in reality a diverse collection of ideas or events. For instance, the statement "my co-workers are being unpleasant to me" is shorthand for a conglomeration of memories of unpleasantness. Different processes encapsulating C5 may focus on different specific memories.
Obviously, the belief C0 is a pattern among the three beliefs that follow it. To suppose that each of the mental processes corresponding to C1, C2, and C3 is equipped with a generalization routine of the form "When encountering enough other beliefs that contain a certain sufficiently large component in common with me, create a process stating that this component often occurs". If this is the case, C0 may also be created by the cooperative action of C1, C2, and C3, or some binary subset thereof.
One might wonder why the process corresponding to, say, C1 should contain a generalization routine of this type. The only answer is that such routines are of general utility in intelligent systems and that they add only negligible complexity to a process such as C1, which deals with such formidable concepts as "food" and "conspiracy". In a self-organizing model of the mind, one may not assume that recognitive capacity is contained in a single "generalization center"; it must be achieved in a highly distributed way.

Next, what about C1 (food is poisoned by conspiracy)? Taking C0, C2, C3, and C4 as given, C1 is a fairly natural inference. Suppose the process corresponding to C0 contains a probabilistic generalization of routine of the form "the greater the number of events that have been determined to be caused by conspiracy, the more likely it is that the event X is caused by conspiracy." Then, when C0 combines with C2 and C3, it will have located two

events determined to be caused by conspiracy. And when this compound encounters C4 (the food tastes bad), the generalization capacity of C0 will be likely to lead to the creation of a belief such as C1 (the food is poisoned by conspiracy). So C1 is produced by the cooperative action of these four beliefs.

In what sense is it a pattern in the other beliefs? It is a pattern because it simplifies the long list of events that are summarized in the simple statement "My food is being poisoned". This statement encapsulates a large number of different instances of apparent food poisoning, each with its own list of plausible explanation.

Given that the concept of a conspiracy is already there, the attribution of the poisoning to the conspiracy provides a tremendous simplification; instead of a list of hypothesis regarding who did what, there is only the single explanation "They did it". Note that for someone without a bent toward conspiracy theories (without a strong C1), the cost of supplying the concept "conspiracy" would be sufficiently great so that C1 would not be a pattern in a handful of cases of apparent food poisoning. But for Jane, (C4/C1,C0) < (C4/C0).

Relative to the background information, C0, C1 simplifies C4 because the fact that the food tastes bad is a logical consequence that there is a conspiracy against Jane. Clearly, C2 and C3 may be treated in a manner similar to C1.

Now let us return to the last three belief processes. What about C5, the belief that her co-workers are acting unpleasantly toward her? First of all, it is plain that the belief C2 works to produce the belief C5. If one believes that one's co-workers are conspiring against one, one is far more likely to interpret their behavior as being unpleasant. Furthermore, given C2, the more unpleasant her co-workers are, the simpler the form C2 can take. If the co-workers are acting pleasant, then C2 has the task of explaining how this pleasantry is actually false and is a form of conspiracy. But if the co-workers are acting unpleasant, then C2 can be vastly simpler. So, in this sense, it may be said that C5 (my friends and co-workers are unpleasant to me) is a pattern in C2 (my friends and co-workers are part of the conspiracy). By similar reasoning, it may be seen that C4 (the food tastes bad) and C6 (My leg is in extreme pain) are both produced by other beliefs in the list and by patterns in or among other beliefs in the list.

It follows from the above arguments that Jane's conspirational belief system is in fact a structural conspiracy. It is approximately a fixed point for the "cognitive law of motion". A more precise statement, however, must take into account the fact that the specific contents of the belief processes C1 are constantly shifting. So, the belief system is not exactly fixed; it is subject to change but only within certain narrow bounds. It is a strange attractor for the law of motion. Whether or not it is a chaotic attractor is not obvious from first principles; however, according to Goertzel, this question could easily be resolved by computer simulations. One would need to assume particular probabilities for the creation of a given belief from the combination of a certain group of beliefs, taking into account the variety of possible belief processes falling under each general label C1. Then one could simulate the equation of motion and see what occurred. In his opinion, there is a strong suspicion that there is indeed chaos here. The specific beliefs and their strengths most likely fluctuate pseudo randomly, while the overall conspiracy structure remains the same[115].

[115] Benjamin Goertzel, *op. cit.,* Page 127-128.

Jane’s belief system in Goertzel’s story is severely paranoid; although there exist different levels of paranoia, it should be admitted that in general terms, the conspiracy theorist, the generator and transmitter of conspiracy rumors shows a certain degree of this type of mental disorder.
Conspiracy theories, prejudices, paradigms, changing values or prohibitions (that which is related to certain social taboos such as sex, drugs, easy money, or power) tend to attract rumors to their sphere and therefore constitute powerful strange attractors.

4.6.5 Rumor from the Conflict Theory

According to Abraham, since the classic demonstrations of acquired aversive drives conducted by Estes & Skinner and Miller[116] there has been an evolution of studies of the effects of classically conditioned drives, called conditioned emotional responses (CERs). Some are quite mature in considering all the logical possibilities of aversive- appealing interactions between CER and the instrumental reward[117]. One of the most interesting is the model of approach-avoidance conflict[118]. In an attempt of extra-polarization, conflict will be used here as to rumor acceptance or avoidance under conditions of uncertainty and fear before a highly relevant event.

Following Miller’s linear model, let us assume the occurrence of a highly unusual event; for example, the death Princess of Wales in a “strange” accident, together with an Arab young man disliked by the Great Britain’s Royal family arises a wave of rumors.
As time goes by there is no official release, and the public opinion is filled with uncertainty, anguish, and anxiety. A couple, Jack and Jill, who happen to be walking along a street in London, learn about the issue when they overhear two passers-by commenting on an “attack against Diana Spencer-Dodi Al Fayed”.
Their positive-appetite and negative-aversive CER gradients were different for each of them as well as for their friend, Piggy, who was geographically distant at the time of this fearsome incident.
Jack, who was more shocked, has a high aversive gradient towards gossip, especially towards conspiracy rumors. On the contrary, Piggy has a high appealing/ appetitive gradient for gossip and tends to believe everything she is told. Jill is in-between, the aversive gradient exceeding the appetitive gradient. Conversely, her attraction towards the rumor increases until it exceeds the aversion gradient as she hears that the news about the accident is likely to be true (remember the concept of Granovetter’s threshold).

The vector fields for these hypothetical variables are considered a linear function of distance from the rumor, and they are additive. The rate of change of attitude to or from the rumor is thus a linear function of its credibility. On the other hand, the vectorial field for this observable behavior is also a linear function of attitude regarding the rumor. The manifold, the state space, is thus a straight line, and reveals that Jack would not have

[116] Frederik Davis Abraham, *op. cit.* , Page 159-160.

[117] J. Koerner, *Non Linear Dynamic Systems in Behavioral Psychology* (Vols 1 y 2, Unpublished Doctoral Thesis, University of Minnesota, 1992), in Robin Robertson y Allan Combs (edit.): *Chaos Theory in Psychology and the Life Sciences*. (New Jersey, Lawrence Erlbaum Associates Publishers, 1995). Page 160.

[118] Frederik Davis Abraham, *op. cit.* , Page 160.

believed the rumor, Piggy would have accepted it as conspiracy, and Jill -anguished and fearful as to its veracity- would have been doubtful as to accept it or not. The three states are very different point attractors. Note that opinion and attitude are interactive variables; attitude changes Jill's and Jack's opinions, which changes their conditioned emotional responses, which in turn changes their opinions. Miller recognized this interaction under the title dynamic relationships. [119]

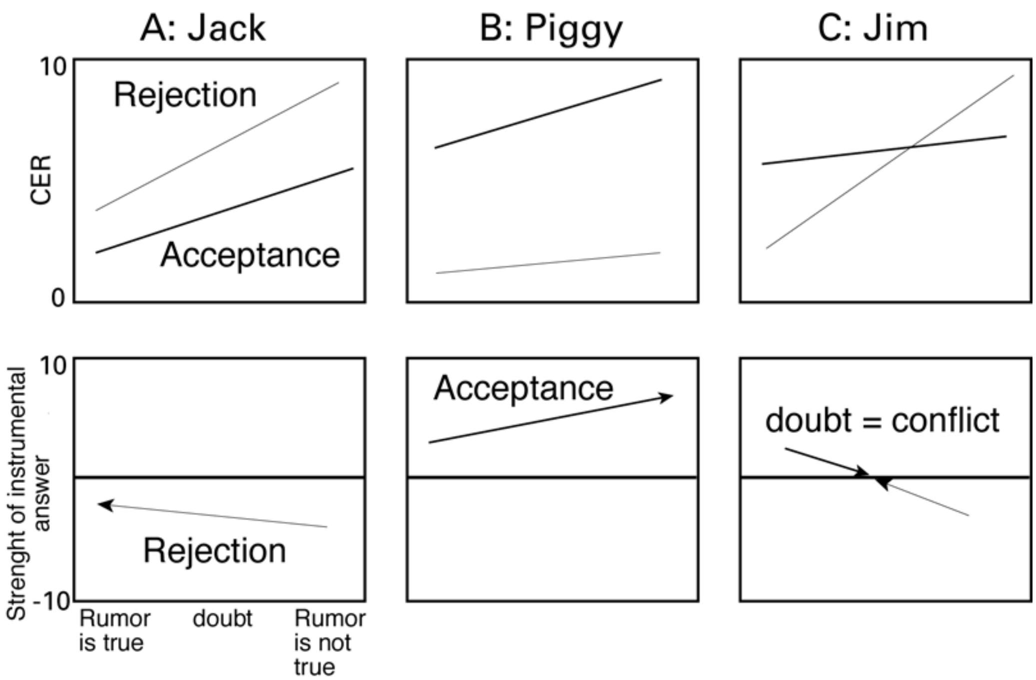

Figure 1

Approach-avoidance conflict: Miller's linear dynamical model. Appetitive and aversive CERs (conditioned emotional responses, vertical axes of upper row of graphs) and distance to rumor (horizontal axes) gradients, established by learning. These two gradients are additive to result in an instrumental response strength (vertical axes of lower row), resulting in the observed variables of rate and direction of motion in the space. Jack always avoids the rumor, Piggy always accepts it, but Jill's crossed gradients have her believe it or reject it depending on what she hears, but always ending up in the middle, i.e. doubt, because of the equality of aversion and desire there. Jill is exhibiting conflict; the two tendencies compete. Adapted from Abraham et al (1990).

4.6.5.1 The Non-linear Model

To exhibit more complex behavior, the vector fields (CER gradients) were made a function of not only distance to rumor acceptance-avoidance, but also the direction and magnitude of velocity of change of attitude (Fig. 1). In Jill there is cognitive distortion -perceptual distortion in the stimulus sampling process- with a hysteresis effect in that, when hearing the rumor, the aversive gradients are depressed but come back to dominate at the attempt

[119]N.E. Miller, "Liberalization of Basic s-r Concepts: Extensions to Conflict Behavior, Motivation and Social Learning", in Frederik Davis Abraham, *op. cit.* , Page 160.

of convincing her on something she does not want to be true, and she flies to rejection. (Fig. 1, left).
While this takes place, the sampling of aversive cues dominates, and she finally realizes the confabulation. She slows down, resets the cognitive appraisal or sampling process, and the appetitive gradient dominates and turns her around again: she thinks that the rumor may be true. (Fig. 1, right).
There may result a damped oscillation to a spiral (focal) fixed point attractor (Fig. 2, lower mid-right), as the pendulum in Chapter 3. Or there may be continually undamped oscillation, a periodic or limit-cycle attractor (Fig. 2, lower mid-left) , as in the trout-sturgeon example. [120]

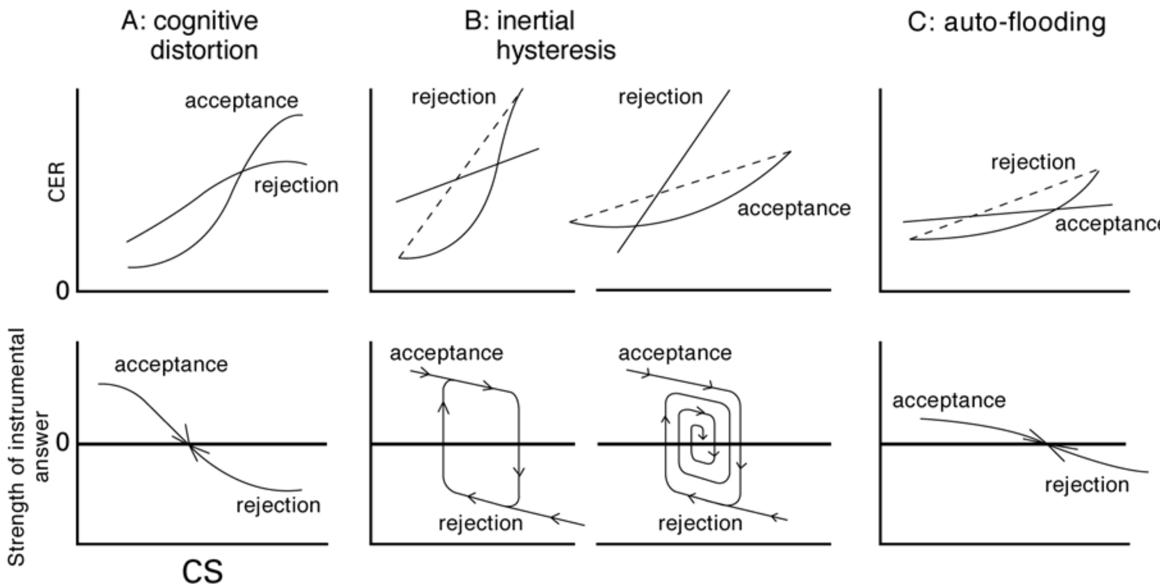

Figure 2:
Approach-avoidance conflict: Non-linear dynamical model. (A) Simple cognitive distortion, Lewin's model, fixed point attractors. (B) Cognitive distortion with hysteresis. The gradients are a function of the direction and velocity as well as the distance from the rumor. They are different during approach and avoidance. (C) Auto-flooding, due to the slowness of motion, or deliberate self-exposure to the rumor, there is habituation, a lowering of the aversive gradient. Adapted from Abraham et al (1990).

These processes are under the influence of other forces, often with quasi-periodic characteristics, such as the level of credibility, the importance of the event for the actors, the credit of the people who pass on the news, and so on, so that these attractors can become more complex, spreading over the surface of a torus (strange attractor) whose phase is following these forces, and thus exhibit chaos.

[120] J. Briggs y F.D. Peat, *Turbulent Mirror: an Illustrated Guide to Chaos Theory and the Sciences of Wholeness*, (New York, Harper and Row, 1989). Page 37.

When this is the case, the response diagram is shown with a general sensitivity to fear as a control parameter (Fig. 3). It shows a sequence of subtle bifurcations from fixed point to periodic or limit-cycle, and excitement to chaos.[121]

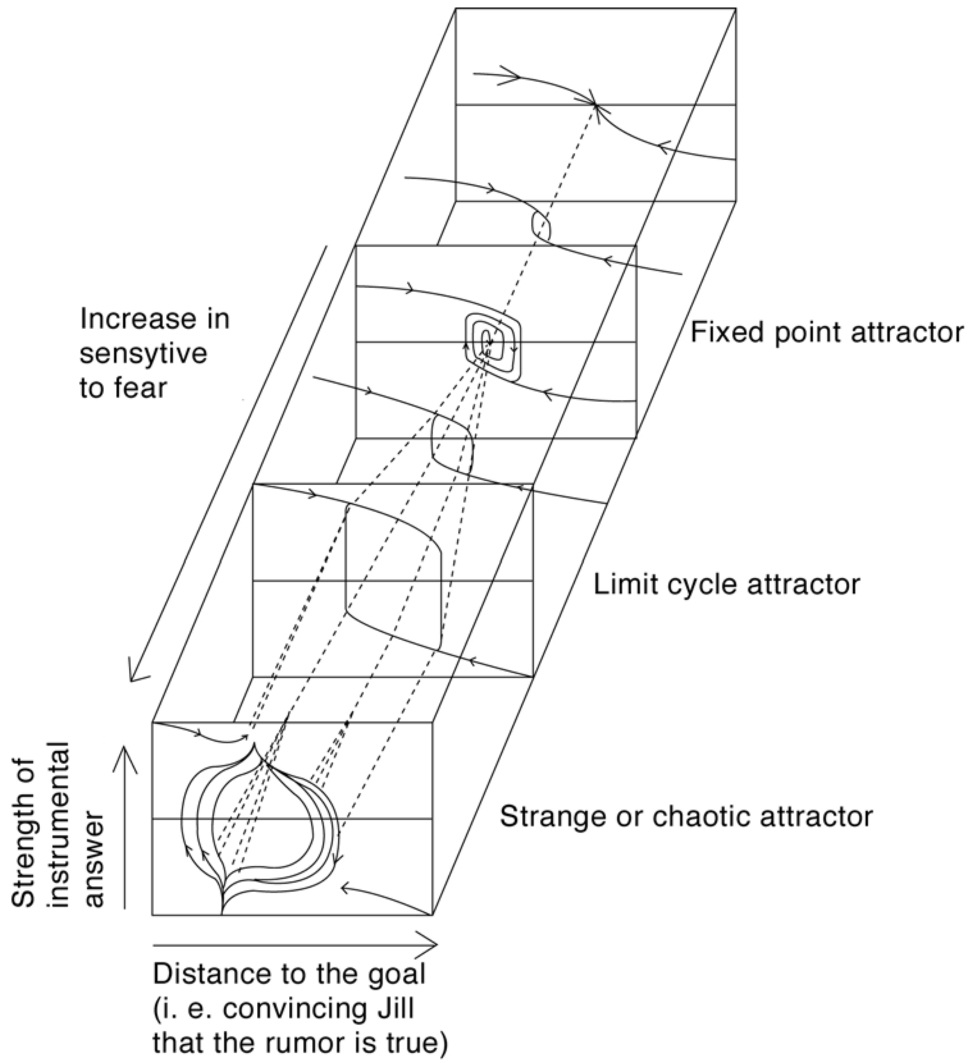

Figure 3:
Response diagram of dynamical scheme for conflict. Dimensions of the state spaces (vertical spaces) are response velocity and position with respect to a goal. The control parameter is sensitivity to fear. With increasing sensitization to fear, the sequence of subtle bifurcations first exhibits a Hopf (from a fixed point to a periodic attractor) and then excitation of chaos (periodic to chaotic, the chaotic is shown as the collapsed shadow of a trajectory wound around a torus). Adapted from Abraham in McGraw-Hill Yearbook os Science (1993).

As it can be seen, behavior towards rumor becomes more complex; it can change in itself and self-organize as individuals' behavior towards rumor join the others' behavior.

[121] *F. D. Abraham,* The McGraw-Hill Yearbook of Science & Technology. *(McGraw-Hill, 1993). Page 157*

It is obvious that an individual can decide by himself without the involvement of another. However, it is interesting to analyze the behavior of the model coupling two individuals displaying such conflict.
In place of two individuals, you may substitute two components of an organization or social structure, for example two groups in which one agrees with the content of the rumor and the other disagrees with it.

When two participants or "oscillators" are coupled, the bi-dimensional state spaces of each are combined in a four-dimension state space.
For a three-dimensional representation on a two-dimensional computer screen, it is usual to make the plane for one participant perpendicular to that of the other, and let the origin of it follow the trajectory of the other with a polar orientation, such that if they were uncoupled and each oscillated at a fixed frequency, their joint trajectory would approach and follow the surface of a torus (Fig. 4).

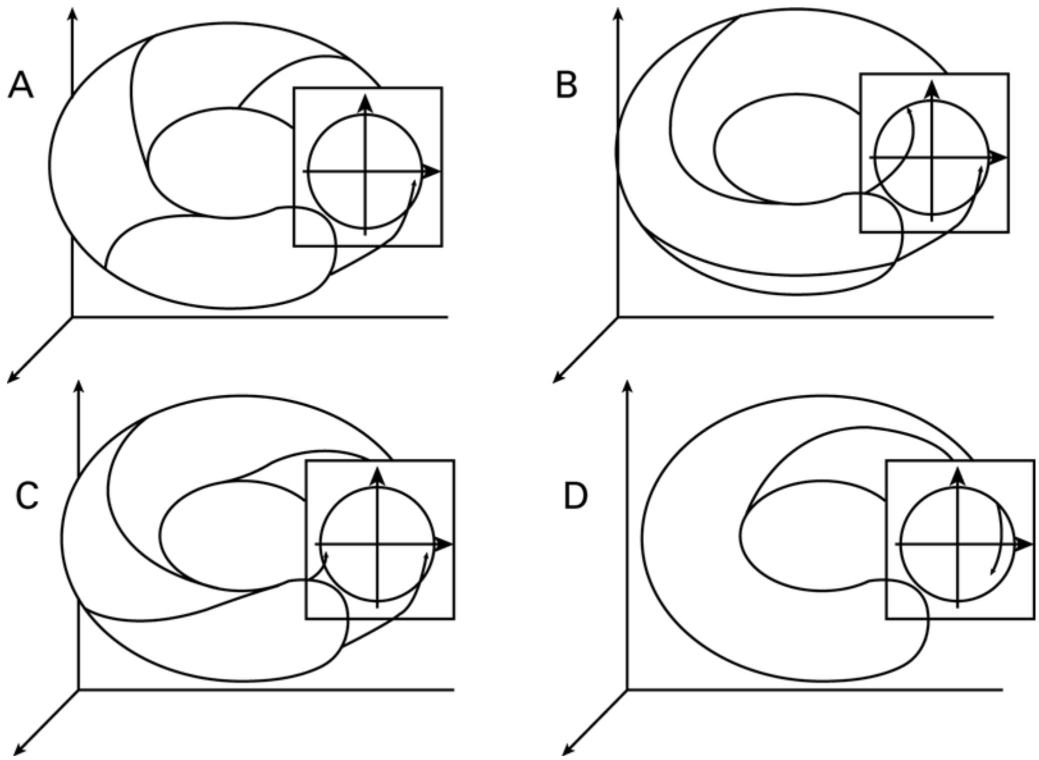

Figure 4:
4D state space for two uncoupled individuals. The state space for one individual is velocity vs. Position (belief versus disbelief) on the horizontal plane, for the other individual the state space is on the vertical plane. Here, to help visualize the space, a torus is shown for the two uncoupled individuals (1=0) each oscillating with constant amplitude, shown with winding ratios of (A) 3:1; (B) 1:3, (C) 3:2, and (D) irrational where the winding of the trajectory never repeats, that is, is a chaotic attractor rather than a periodic attractor as with the others (some authors do not include this case as chaotic as it does not possess sensitivity to initial conditions.[122]

[122]Frederik Davis Abraham, *op. cit.* , Page 164.

In this first model the rate of change in position of each of the individuals is a function of the position of the other. Future simulations will explore various types of such couplings where the position of belief or disbelief of one individual can be coupled to the position of belief or disbelief of the other as well as the velocity of change of attitude of the other. [123]

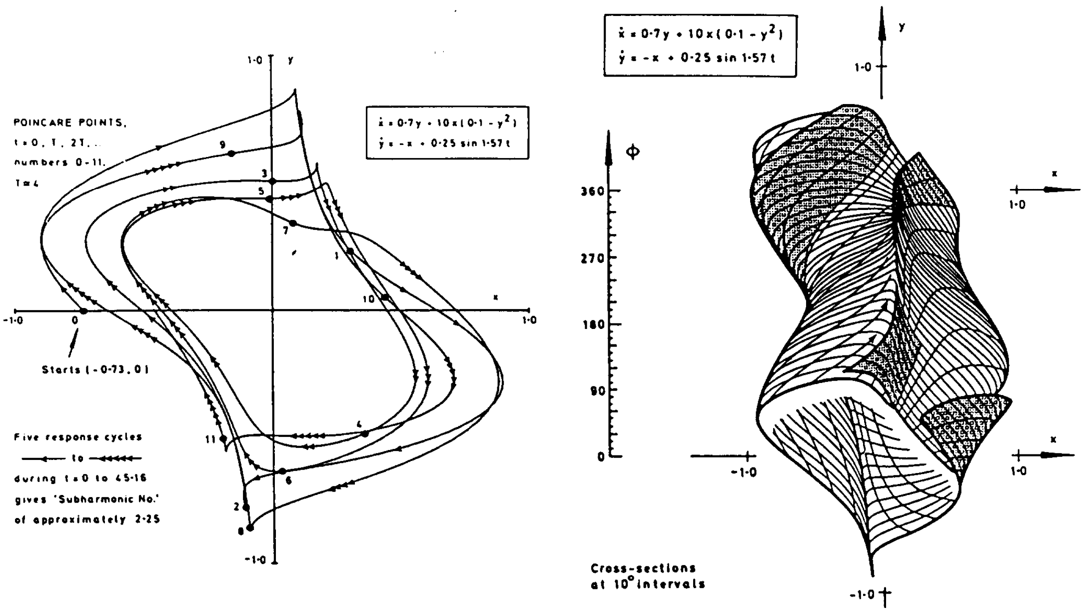

Figure 5:
Example of Poincare Section (bi-dimensional, to the left) and 3D (partial) simulation to the right of a torus attractor for the behavior of two individuals coupled in conflict. From Thompson and Stewart (1986), reproduced in Chaos Theory in Psichology and the Life Sciences (1995).

In the coupled conflict model, described by mathematical equations and simulations and graphically represented in Figure 5, the variables are coupled directly, thus creating a higher dimensional state space. This differs from the network model of Figure 6, where a system's control parameter is a function (under influence) of the state of the other. Anyway, some of the couplings can be weak or eliminated, for example, if Piggy does not care what Jack thinks. Another coupling might be strong such that one was completely entrained to the other: Jack may follow Piggy completely. This would represent the extreme case of non-symmetrical coupling. Intermediate couplings are more likely, but still quite asymmetrical.
Jack might finally disagree with Piggy's position if what she told him were too absurd or if it showed a groundless rumor.
This type of feedback enables self-control. If they exert influence on each other, this influence feeds back to the originator. This constitutes the self-organization process in social systems.

[123] Frederik Davis Abraham, *op. cit.* , Page 166.

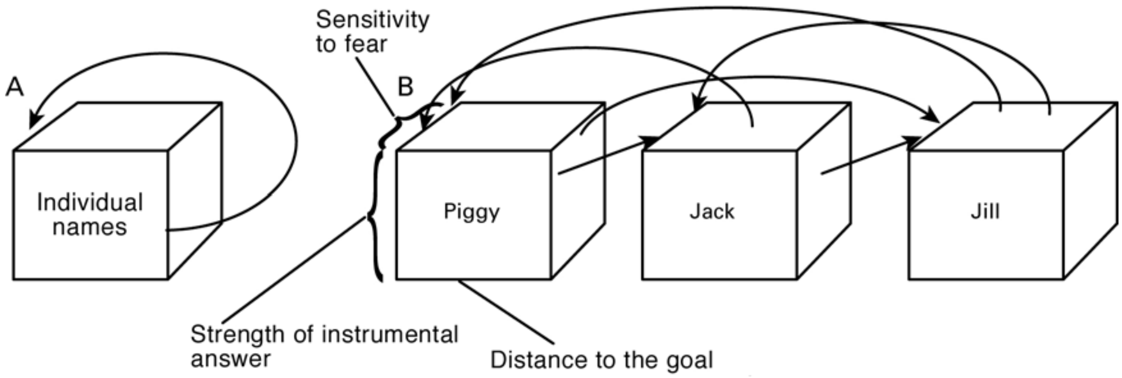

Figure 6:
Network diagram. It is possible to deconstruct a complex dynamical system into several sub-systems, each with its own control parameters. It is also possible to combine several simpler systems into a larger one, as a network with the control parameters of each dependent upon the states of some of the others.
When the control parameter(s) of a system are influenced by the state of the system itself one can speak of self control or self-organization.
The figure shows network diagrams. (A) Self-control (direct), (B) Complex dynamical system comprising of three coupled dynamical schemes (with indirect self-control). The control parameter of each scheme is influenced by the state of each of the other two schemes. The schemes are the same as Figure 2. Adapted from Abraham et al (1990).

We just described Jack with his avoidance-dominated system, who is strongly coupled to Piggy. He follows her even when he does not believe the rumors. She is an opinion-leader (weakly coupled to Jack) and possesses a stronger gossip-dominated system. But Piggy could have been more of a follower, though we do not usually think of personality traits of leadership or assertiveness and conditioned fear being dissociated this way. We think of leaders as fearless, and followers as those who tend to follow to be protected from the imagined sources of their fears and anguish. But this is not necessarily the case. Network coupling may be more passive, operating in linear real time. The participants follow their gradients, influence each other, and themselves, by network feedback, without being particularly aware of their own control parameters.
A more active situation occurs when each individual learns to control a parameter of their own conflict system, in which case they may choose the attitude “I should filter what I’m being told. I’ll ignore the fear or get used to it” (Fig. 2 C). Or they may try to influence the behavior of the other person, and condition their own fear parameter upon the response of the other. Piggy knows the difference between hers and Jill’s phase portrait, so she gets Jill into the space. “Have you heard what’s being said, Jill? It is true, isn’t’ it?”. She modifies her behavior by modifying Jill’s. This is called enticement coupling.

Rumor, as seen in Chapter 1, is a phenomenon occurring under special conditions, uncertainty, lack of information, concern, even panic, as in catastrophes and wars. The conflict that provokes doubt as to its veracity or falsity can reside, as exemplified by Jack, Jill and Piggy, in a fixed-point attractor (there are doubts until decision is taken either for its veracity or falsity): in this case, the individual will soon find relax or equilibrium (he is convinced of this decision and calms down). In a limit-cycle attractor, periodically changing

from belief to disbelief; or else in a strange attractor (“we don’t know who to believe) with unpredictable, chaotic consequences for behavior.
As shown by Abraham, this is not simple since the individuals’ mutual influences through their interactions and attitudes add to the complexity of the social system around the rumor. The personality and mental state of individuals greatly influence them either to accept, spread or reject a rumor[124].

4.6.5.2 Ambiguity and Uncertainty as Control Parameters

As seen in figure 3, in terms of ambiguity and uncertainty, fear is used as control parameter of the dynamical diagram for the conflict scheme. According to Rumor Theory, chapter 1, this is a fundamental parameter for rumor generation and transmission. It is therefore of special interest for specific analysis.

This is an increasingly less predictable human world. People go to sleep without knowing what the next day will bring and how it will affect their lives. The regularities of yesterday get more and more disorganized. Randomness, uncertainty and unpredictability, stress and crisis play a major role in human life. In this world the butterfly effect abounds: the lack of proportion between cause and effect is increasingly higher. In times of discontinuity, there are more problems to generalize one case or another. Randomness enters human lives with more strength and impact.
The future is hard to predict and to plan because in times of discontinuous changes, the trajectories of the future have become impossible to calculate. At this point, without seeing the total model, the ability to control the future goes down. Only when we start to perceive the features of the pattern in chaotic transitions do we return the ability to produce an effect in the future to the human agency.
As the world becomes more uncertain, the individual and social needs of order and regularity are threatened. The platform provided by living in a world supported by firmness, regularity, stability, certainty, order, predictability, generalization and control disappears. These fading features and the growth of crisis and deep chaos bring about stress, anxiety and fear. There is no certainty for humanity to step on firm ground in the future either. The growth of uncertainty, in the shape of proliferation of crisis and multiple chaotic periods, gives way to major changes in the human condition.

The increase of anxiety in everyday life is a reaction to the intensification of uncertainty in these times. The loss of the stable state and the destruction of the anchors of personal security have given rise to the widespread prevalence of anxiety as a regular feature of daily life.
The American Psychiatric Association defines anxiety as apprehension, tension and uneasiness which stems from the anticipation of danger, the source of which is widely unknown or unrecognized. Anxiety is the fear of a nameless dread, a kind of floating fear unattached to a particular source. The emotional overload of dealing with too much uncertainty and too many unpredictable, threatening events may lead to a marked rise in the measure of anxiety in people’ lives. At the level of individual’s lives, proliferating

[124] *Frederik Davis Abraham,* op. cit.

uncertainties overwhelm people. As T. R. Young (1994) points out, a person can generally manage with one uncertainty such as a health problem. Often two uncertainties, such as a health and family problems can be dealt with. But if to these are added loss of a job and economic insecurity together with the insecurity of living in a crime-ridden area, the uncertainties can be overburdening[125].

Living in a world that bombards people daily through the radio, newspapers, and television with endless details of accidents, disasters, crises, criminal acts, wars, and other tragedies, makes anxiety a constant companion. The constant growing uncertainty feeds fears and escalating apprehension of hidden, unidentified, and unexpected dangers that facilitates rumor generation and proliferation.

Kenneth Pelletier of the Langley Porter Neuropsychiatric Institute points out that when a major social change occurs, there is always stress on individual members of the society. Writing about the combination of mounting change and the growth of information media, he says that at all levels of society, people have to adapt to a changing world-view. This kind of evolution has occurred throughout history, but communication systems now propagate these ideas and attitudes at an unprecedented rate. According to him, "when the source of stress is ambiguous, undefined, or prolonged, or when several sources exist simultaneously, the individual does not return to a normal mental and psychological baseline as rapidly. He or she continues to manifest a potentially damaging stress reaction. This concept is fundamental to the understanding of psychosomatic disorders "[126].

In these times, modern man is subject to more and greater situations of ambiguity, uncertainty, and fear than have ever been experienced at any other time in human history, and its effect is often devastating.

The amplifying and intensification of internal stress in its psychological forms may be the parallel of internal gradients in chemical systems (Prigogine's terms). With people the aggravation of external perturbations in the form of multiplying uncertainties aggravates internal insecurity and inflames the intensity of stress. Sometimes, the perturbations of stress snowball into proportions that can no longer be handled by the person's physical or psychological structure. He or she reaches a psychological bifurcation point that may lead to breakdown or chaos in his behavior.

The common adaptive reaction to uncertainty is to try to repeat with greater effort what has been tried before. This is doing more of the same (point, cycle and torus-like behavior). Accustomed to ways of thinking and behaving, most people have difficulties changing beliefs and assumptions developed throughout their life. Many believe that dominating and controlling people and conditions will guard them from uncertainty so they try even more to control and dominate. They do more of the same. Afraid of the unexpected and unpredictable, people attempt to structure their daily life. They follow daily routines of repetitive behavior that provide a safe haven of certainty in the face of the growing uncertainty enfolding them. In order to attain control, some strive with greater efforts to attain power in some form, generally that of wealth. Wealth is seen by many as a means of gaining control over unpredictable circumstances and ensuring safety from life's uncertainties.

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[125] T.R. Young, *Chaos and Causality in Complex Social Dynamics*. (Michigan, The Red Feather Institute. 1994).

[126] *Kenneth R. Pelletier,* Mind as Healer, Mind as Slayer*. (New York, Delta Books. 1977).Page 5.*

In their immediate environment such as family, workplace, leisure activities, people do all they can to build around themselves a cocoon of certainty in the form of repetitive or slightly variable (torus) behaviors. When they are troubled by changing circumstances they make every effort to return to their former regular and reliable ways of functioning. However, when something unexpected occurs (perturbation of the system) and rumors flow, the event becomes shocking and the structure of safety can fall apart like a house of cards.

Sometimes anxiety and fear to the unknown and unexpected lights the fire of hatred to what is different. The others -those of different color, religion, nationality, or culture- are considered the source of all difficulties and problems, and the increasing anxiety, tension, stress, and fear are attributed to them. Racial hatred and discrimination movements flourish in times of uncertainty. It is in those situations when prejudices become strange attractors of rumors.

Certain types of rumors, e.g. the possible loss of o job or the participation of a beloved one in a severe accident, generate a high level of uncertainty and unpredictability; they manifest in unstable relations among the people affected with turbulence, sensitivity to small differences and a greater degree of freedom.

People react in different manners when faced with chaotic uncertainty and confusion. The most common reaction is loss of security.

Anxiety, impotency, helplessness, hopelessness, aloneness, loss of security, placelessness, being drawn into a vacuum, holding on to the familiar, turning inward, abandonment, conflict over boundaries, resistance, operating defense mechanisms, unpreparedness, seeking others, excitement, fantasy, resilience, creativity, intuition, these are expressions people gave to their feelings and actions in reaction to a growing state of chaotic crisis[127]. Most of the feelings have a negative connotation, a few are neutral, and some are positive. As a whole people's gut reaction tends to be more unfavorable than favorable. They are less aware of the important creative functions of chaotic confusion.

Turbulence an chaos in a time of transition are experienced as somewhat like the feeling of a person caught in an earthquake. The earth itself, the basis of all security and balance, is shaking under one's feet. The sudden explosion of many unpredictable events in a person's life and the exposure to a plethora of turbulent happenings tumbling capriciously and tempestuously into one's world is felt as a trembling of the very foundations of security, a loss of the stable state. The same emotions affect people in organizational crisis.

The passage through chaotic transition undermines the belief in the stable state and strikes at the very heart of people's feeling of constancy, steadiness, predictability, and security. The emptiness and void of the transition period deprives people of the anchors that gave stability and meaning to their lives. These anchors of values, belief systems, institutions, and roles that are the sources of order, continuity, and meaning in life break down or are in crisis before the onslaught of the transition stage[128].

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[127] Uri Merry, *Coping With Crisis* (in Hebrew). (Tel- Aviv, Cherikover. 1990).

[128] Uri Merry and George Brown, *The Neurotic Behavior of Organizations*. (Cleveland, The Gestalt Institute of Cleveland Press. 1987).

“Crisis (resulting from rumor) involve positive feedback loops which perturb the self system with destabilizing fluctuations. We can define crisis as an encounter with information which cannot readily be converted into habitual cognitive and behavioral patterns ... anxiety accompanying this recognition is distressing and demands resolution. A cognitive reorganization to incorporate the new data brings a decrease in anxiety and leads to new, more functional alternatives of behavior”[129].

4.7 Basis for a Mathematical Model of Rumor

Being able to build a mathematical model for a social process is every researcher’s dream, because if the model does actually comes close enough to reality, it will be possible to predict the future behavior of the system in question.

The problem in the design of a mathematical model is not an optimization problem. That is, it is not a question of incorporating all the requirements in the best possible way, but rather to integrate the fundamental variables and parameters, keeping arbitrariness level as low as possible. If the model were to incorporate all the variables and parameters considered below, its complexity would probably render it not viable. That is the reason why it is of utmost importance, for each variable and each parameter to be clear and specific enough in their formulation.

For quantifiable variables, this is simple. An obvious example is referred to the individuals in the transmission chain. Since we can simplify their classification into two groups, transmitters and resistants, we can assign value 0 to one group and 1 to the other.

For non-quantifiable variables, it is not that simple. Let us take the level of credibility or critical sensibility. They do not have an objectively measurable property. It will be necessary to determine a scale and to establish an arbitrary correlation with individuals as approximate as possible.

This leads us to three basic and hard-to-answer questions before shaping the model:

1. How can we obtain a thorough set of **M** variables for a given rumor (case)? In other words, how can we be sure that we have not forgotten an important aspect that the model should consider?

2. How can we know if all the variables included in **M** are really relevant to the problem?

3. For each specific variable, how do we decide at which point a disadjustment has occurred? Or, for a continuous variable, how do we know what value to assign as standard performance?

The inclusion of such variables and parameters will depend on the desired model complexity, as well as the arbitrary values to be assigned to obtain the simplest possible model while reflecting an acceptable reality.

[129]Glen A. Perry, “The Evolution of the Psyche”, *World Futures* (Nº 36, 1993). Cited by Uri Merry, *Coping With Uncertainty: Insights From the New Sciences of Chaos, Self-Organization and Complexity*. (Westport, Praeger Publishers. 1995). Page 237

A relatively easy mathematical model of rumor diffusion is the one described below. It comprises a population made up by only three types of people: the ones who know the rumor that is being spread; the ones that are ignorant of the rumor, but when they learn it become transmitters, and finally, the ones that are ignorant of the rumor and when they learn it, do not spread it (the immune, according to the epidemiological model).

This mathematical model is constituted by a system of differential non linear equations, with no analytical solution in the sense of a set of successions that allows us to obtain the evolution of the number of individuals in each of the above mentioned categories that work for any given initial condition. The independent variable is time, considered a discreet variable. The population is analyzed by time periods (hours, days, months or any chosen time unit).

The only way to find a solution to this model is through the use of a computer program. One of the most widely used programs of this type is Mathcad.

Some of the questions this simple model can answer are, for example: when can the rumor diffusion process be considered extinct? Does it depend on the initial number of transmitters? How does the contagion parameter condition the end of the transmission? When is the peak number of transmitters?, etc, etc.

Initial Conditions

$x1_0 := 999$ number of people who do not know the rumor

$x2_0 := 1$ number of people who spread the rumor

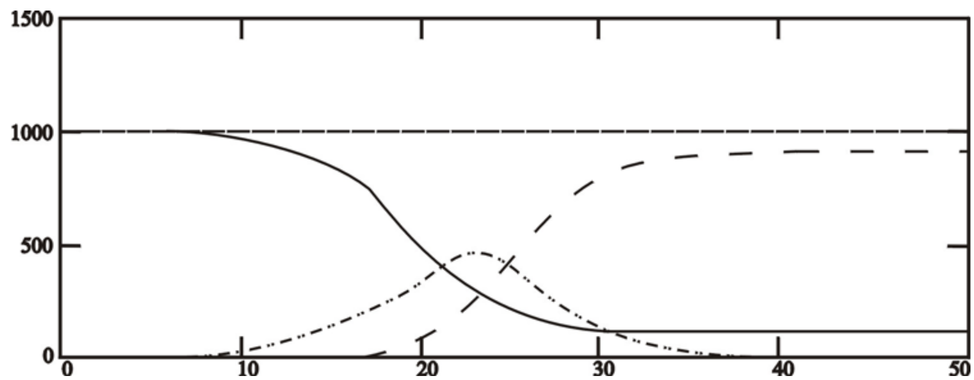
$x3_0 := 0$ number of people who are immune to the rumor

Contagion Parameter $F := 0.0004$ (only parameter in this model)

$M := 50$ time series $k := 0..M$ $h := 1$ time unit

Mathematical Model

$$\begin{bmatrix} x1_{k+1} \\ x2_{k+1} \\ x3_{k+1} \end{bmatrix} = \begin{bmatrix} x1_k - h.(F.x2_k.x1_k) \\ x2_k + h.F.\left(x2_k.x1_k - x2_k.\dfrac{x2_k - 1}{2} - x2_k.x3_k\right) \\ x3_k + h.F.\left(x2_k.\dfrac{x2_k - 1}{2} + x2_k.x3_k\right) \end{bmatrix}$$



Graphic representation of variable evolution

$x1_k$ = number of people who do not know the rumor
$x2_k$ = number of people who spread the rumor
$x3_k$ = number of people who are immune to the rumor
$x1_k + x2_k + x3_k$ = total population

From the graphic shown, we can deduce, for example, that the maximum number of people spreading the rumor over a total population of 1,000 is 456; that the maximum diffusion peak is in period 22; and that if we assume that the diffusion process is extinct once only 20% of the population ignore the rumor, it can be considered extinct in period k = 26 (the transmission duration).
From what we have seen in this paper, it is clear that the number of variables and parameters taken into account in this model is extremely limited and is far from representing a real rumor generation and diffusion situation in a social system. A more complex model undoubtedly needs to consider more parameters and many more variables. Below, there is a description of the main ones.

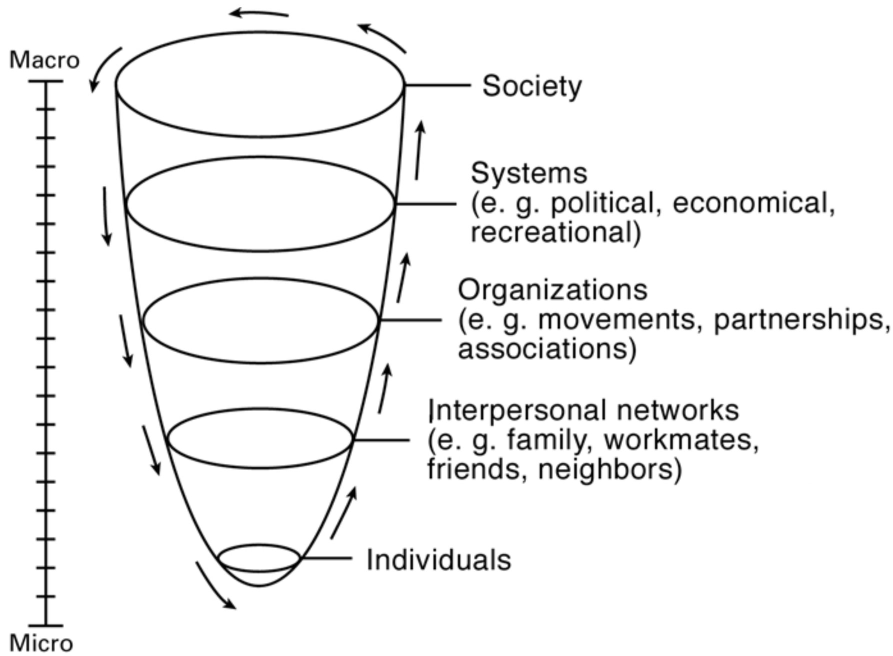
4.7.1 The Model's Components

4.7.1.1 Definition of the Control Parameters

Ambiguity: lack of certainty about something that arouses uncertainty and, consequently, fear. In this sense, ambiguity, uncertainty, anxiety, and fear can be synonymous. The greater the uncertainty, the longer the perturbation transition period (rumor).

The importance of the topic: the weight of the rumor-related issue for the population. The more important the topic the more the rumor is spread.

Importance is not only regarding its degree but its scope: it can be within a group (e.g. an organization), or at a global scale (e.g. JFK assassination). In this case, the importance will be fractal, from the smallest group to the global scale, as shown in the graph.



Fractal dimension of rumor audiences, from the smallest group to the global scale

The more important the topic and the longer the transition period, the higher the probability of distortion, and consequently, of system bifurcation. On the other hand, the more global the rumor, the more likely it will be for its strange attractor to be formed by a conspiracy theory.

Critical sensitivity: it is related to the people's critical sense towards a specific topic. Critical sensitivity has to do with the individual's IQ, personality and his level of information. Critical sensitivity determines rumor acceptance or rejection.

In Chapter 1 we mentioned Allport and Postman's rumor diffusion model: R = I x a. This means that rumors related to a specific topic will circulate in a group proportionally to the importance (i) and ambiguity (a) in the lives of group members[130].

Chorus[131] states that the opposite to critical sensitivity 1/c is to be included as a multiplying variable of Allport and Postman's formula, i.e. R = i x a x 1/c, because as individuals' critical sensitivity increases, rumors weaken and stop, while someone with low critical sensitivity is a prospective candidate for rumor because he accepts anything without

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[130] *G.W. Allport and Leo Postman,* The Psychology of Rumor *(In Spanish: Buenos Aires, Editorial Psique, 1988)*

[131] A. Chorus, "The Basic Law of Rumor", *Journal of Abnormal and Social Psychology* (Nº48: 313-14, 1953) Cited by Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976), Page 52.

criticizing. The multiplying sign expresses that it is a “all or nothing” relation: if the content is neither important nor ambiguous (or if critical sensitivity is extremely high) the rumor is null. Of course, those situations completely void of ambiguity are not frequent: in addition, all aspects of life have a certain level of importance for an active human being even at minimum level. Besides, this formula has a strong intuition attraction: disasters, assassination, and other crisis are characterized by a high level of importance and ambiguity, low critical sensitivity, and numerous rumors.

Granovetter’s threshold: the number or proportion of people that are to adhere and spread the rumor before one particular individual does.

Percolation threshold: behavior during which, when some parameters present a certain critical value, a phase change takes place, i.e. the system goes from no diffusion to sudden manifestation of diffusion.

Diffusion or Propagation rate is a notion referring to transmission or diffusion speed. In transition time t, the higher the propagation rate, the larger the number of individuals who will receive the rumor.

The level of credibility is related to the alleged source of the rumor, who it is transmitted to, and the content itself. The level of credibility is linked to critical sensitivity.

- **Credibility of the source** (whom the version is attributed to)
  Creditworthy
  Not creditworthy
- **Credibility of the rumor**
  Likely
  Unlikely

Feedback. When feedback is positive the rumor transmission system reaches high dynamic levels, and after successive bifurcations can reach a chaotic state. On the contrary, when feedback is negative, diffusion drops to its equilibrium point where rumor no longer circulates and dies.

4.7.1.2 Variables

The individual’s profile in connection with rumor (Kapferer’s classification [132]):

1. The instigator
2. The interpreter (interprets rumor’s semantics to others)
3. The opinion-leader (influences on others’ acceptance)
4. The apostle (tries to convince the others)
5. The stake-holders (takes advantage of the rumor)
6. The reformer (the teacher who takes advantage of the rumor for their class)
7. The flirt (does not believe the rumor but he likes it)
8. The passive (does not believe it, but...)
9. The resistant (leads the anti-rumor)

[132] Jean Nöel Kapferer, *Rumores. El Medio de Difusión más Antiguo del Mundo*. (Barcelona, Plaza & Janes Editors. 1989), Page 101.

According to Rosnow and Koenig, these variables can be simplified into three types[133]:

The generator is the instigator who makes up the rumor. The socially isolated individual who starts the rumor to attract attention towards himself.

The transmitter or infected who propels the rumor. The "insider" who re-transmits the rumor to show he belongs to the elite, i.e. he has the power granted by information.

The resistant or immune is the one who stops transmission. He represents the "Dead end" of the grapevine.

[133]Ralph Rosnow and Gary Alan Fine, *Rumor and Gossip: The Social Psychology of Hearsay* (New York, Elsevier, 1976).

Fifth Part: Final Conclusions

“One can never anticipate what one man will do,
But one can predict with precision what the average person would do”.
Sir Arthur Conan Doyle (through his character Sherlock Holmes)

According to the previous chapter, the most interesting dynamical forms of social systems are expressed through the models of social science, sometimes lost in a maze of incorrect terminology. Chaos theory, although it seeks to find the patterns in the dynamical performance of complex systems through a long time series and mathematical models as those described in Part Four, provides a number of suitable metaphors for those disciplines where a quantitative approach does not make much sense. These metaphors are of a qualitative nature.

What is important about these new metaphors is that if well selected, they lead to new ideas that in turn lead to new perceptions of reality. This is what this work has intended: to analyze the rumor from another perspective, as a highly dynamical and entropic emerging system, of dissipative diffusion. In other words: a complex system.

From this perspective, we saw that rumor -as any communication system - develops from dynamical and non-linear interactionally related elements with mutual feedback. When feedback is strongly positive the communication system "rumor" adopts the morphology of random perturbations that bring about the surge of chaos. This chaotic behavior is predetermined, i.e. it is deterministic. This determinism is not philosophical but mathematical and it means that the system's inherent unpredictability merely results from the fact that not enough finite information is available for an accurate description that makes a valid prediction of a longer period possible. Remember that the more accurately the status of a system is known, i.e. the more certain we are about the values in each time period for each variable and parameter, the longer the prediction period will be, although this may be possible to a certain extent.

It is clear that this work has exposed the notion that in the study of rumor as a dynamical system it is not possible to separate the analysis of its diffusion from the relative analysis of its content nor from the psychosocial characteristics of the actors involved. Transmission and content of the rumor, as well as the profile of the individuals, are mutually influenced in such a way that the rumor content will determine whether it will spread rapidly or not, while the threshold -the number of individuals who are to share a rumor in order for an individual to be willing to adhere to it- determines the level of transmission, i.e. how many individuals pass it on and how fast.

As seen before, an interesting perspective to analyze the diffusion process of rumors is offered by the models of cellular automata which apply a simple two-way interaction rule: each individual interacts with its neighbors according to the deterministic law of the rule of the majority. According to this law, every position in the lattice adopts the prevailing value between the cell and its four main neighbors. In cellular automata models, the future condition of a cell is a function of the values of neighboring cells and the cell itself. As in epidemics, the willingness to accept and spread the rumor, i.e. the attitude towards rumor, can change after the interaction with other individuals of the lattice. In this sense, the similarity between epidemic models and rumor is very interesting because the main characteristic of these models is percolation, i.e. the filtration process by invasion; it is during this behavior, when some parameters show a definite critical value, that there is a "phase change", i.e. the system turns from no diffusion to its sudden manifestation: the straw that breaks the camel's back. Something similar occurs with rumors. As in diseases, the critical parameter of rumor is how many individuals are prone to transmission in a specific population. As in epidemics, this is relevant in the level of contagion. If this infection parameter is much lower than the critical value, the epidemic dies naturally; if it is much higher, the epidemic spreads endlessly.

This level of probability and the population size affect how long a rumor will last, as shown by the Percolation Theory.
When the number of individuals likely to spread a rumor constitute a population near 6, in fact 0.5928, which is called critical point, the rumor process tends to extend endlessly.
It is also interesting to verify that when the life of the rumor is infinite (p = pc likelihood), the clusters' geometry, i.e. the network formed by the group of individuals transmitting a rumor, shows a fractal dimension – its morphology is repeated regardless of the population size. This seems to be the case of conspiracy rumors, such as the one about President Kennedy's murder, developed on a planetary level and whose end is not yet predictable.

Wolfram's classification showed us that cellular automata models applied to rumor diffusion can give us an idea, though general, of the subtle core structure of the transmission system of this communicational phenomenon. For example, certain types of rumors can represent an example of Class IV behavior by exhibiting very long transitions between its outburst or generation in the local order and its death in the global order. Gossip-type rumors, on the other hand, can mirror Class I dynamics, showing local scales of order. Class II would be represented by urban legends, with limit-cycle attractors determining the re-appearance of these rumors with a certain periodicity. The drawback of these classifications is that they fail to specify how rumors will evolve.

When cellular automata are run, most of the initial configurations lead the model either to "freeze" in a fixed configuration or to form cycles at short intervals. However, we have seen that for models called "hot", i.e. those with a high level of connectivity, configurations are continuously altered; therefore, patterns of a higher scale are unlikely to emerge.
Again: connectivity is a fundamental factor for rumor to appear as an emergent from social perturbation. If connectivity is low, the rumor dies, it freezes; if connectivity is very high, rumor transmission becomes chaotic.

The possibility of combining cellular automata models by applying the iterative prisoner dilemma has been very interesting. Remember that Richards proved a system's chaotic potential in this way by showing that the results of decisions made by an individual's specific neighbors depend on their strategies, and so on. Therefore, the contextual influence of any cell extends beyond the defined radius.

The percolation process models and epidemiology models are, in the light of this work, the most similar to those defined to analyze rumor diffusion. The objective of percolation models is to analyze the length of the process and the morphology of the networks (clusters) formed; in turn, the objective of epidemiology models is to understand and if possible, control the propagation of disease. Therefore, when applied to rumor the purpose is to understand the mechanism of its diffusion and the probable time and manner of its evolution.
The initial distribution of thresholds enables us to predict the number or final percentage of decision-makers. In this case, how many individuals are prone to spreading (transmitters), how many will get infected, and how many are resistant or immune, as shown in the simple model in Part Four. Consequently, the evolution and life of a rumor can be determined through the application of different rates of probability (p).
The metaphor of the epidemic and contagion processes has also suggested that contagious behavior is related to the reduction of restrictions derived from the group, i.e. the reduction of inhibitions on performing an act considered forbidden by personal ideology, group norms or culture (e.g. speaking without being certain about the truthfulness of the content). This is of utmost interest and deserves more attention, as well

as other diffusion models that consider certain characteristics of the environment, such as the level of collective excitement of the population and predominantly local cultural habits that suggest that under high excitement conditions, conventional norms of communicational behavior are left aside. Given this framework, rumors are wildly spread, unquestioned, as epidemics between sub-groups and classes, dependant on the emotional needs, attitudes, and values of the actors.

The so called critical value of epidemiological models is related to the concept of threshold since it is about the level above which the system changes its status, i.e. when there is a second-order change. When the infection or contagion rate among the population exceeds a certain value, an epidemic occurs; similarly, the rumor will have to exceed the average threshold level of the population to spread.

Threshold is defined by the level of interest in the subject, the level of credibility (in the transmitter and the message) and the level of uncertainty and anxiety affecting transmission-prone individuals. The mutual influence of the social structure, i.e. the influence of a given individual on someone's behavior, which can depend on the relationship type, is equally important for threshold distribution. A rumor transmitted by a friend or a reference figure is more valuable and credible than one transmitted by an unknown individual.

We have also seen that different individuals need different levels of certainty before they are ready to re-transmit a rumor. Likewise, they differ as to the expected resulting benefits. A transmitter will have a low threshold since the benefits of passing on a rumor are big for him, while the cost of losing face is low for him. Passing on a rumor can benefit some, e.g. the generator, to the extent of having a 0% threshold. The threshold of conservative individuals, resistant in our case, is very high: the benefits of passing on a rumor are small or negative for them and the consequent lack of prestige is high risk, since they probably are "respectable citizens that only speak when they are certain": an 80% or 90% threshold can be the usual percentage. The threshold of an individual who respects his principles, who not only disbelieves rumors but also contradicts them systematically, i.e. immune, can be 100%.

To summarize, the individual's immediate social background is grounds for deciding whether he is to believe the rumor or not; the decision is influenced by his psychical condition to take this decision, as seen in the analysis of the Theory of Conflict.

At this point, threshold can be defined as the point where the net benefits of passing on a rumor start to exceed the net costs for each specific actor. If the benefit of sharing a rumor is common because it entails a sense of belonging to those who hold the information, i.e. if the population's threshold is low, rumor circulates. On the contrary, if the rumor is unlikely and passing it on results in the transmitter's lack of credibility and image loss (high threshold), feedback becomes negative and the rumor dies. A very high threshold produces no rumor; a very low threshold produces chaotic transmission.

Regarding rumor content, and despite the examples in Chapter two, this work is not focused on the story being transmitted, but on how the story is distorted along the transmission chain.

As seen in Chapter one, rumors are basically spread through informal channels of communication, i.e. word of mouth communication. This means that the rumor has an essentially interactional nature and consequently its content and emphasis depend on the psychosocial characteristic of the narrator. We have seen that feedback plays a major role in the theory of rumor. When a rumor is spread, it is likely to be heard more than once in

the same network and be transmitted to the same person more than once. In this situation, the same message may be liable to distortion and exaggeration. In each step of its transmission process, the rumor will collect new details in a dialectic process, and will synthesize new rumors with new meanings, which in turn can be modified to build up a better story or gestalt. The individual's interaction during rumor-transmission is closely related to the likelihood of a false, distorted and grotesque rumor to emerge; in this situation the rumor will experience the snowball effect, i.e. chaotic transmission. This is so due to the positive feedback process: the rumor which is a non-linear, dynamical and far-from-equilibrium system becomes a self-organized system, in Prigogine's words, given its constant re-generation into new shapes. This characteristic of non-linearity and complexity enables the system to transform itself, the only condition required for activation being the adequate status.

It works like this: the basic content is kept as the leitmotiv until the level of distortion is so great that a second order change takes place: the torus is divided into two tori linked by a butterfly attractor. This is the case of the TWA 800 flight rumor: the theory of the missile is bifurcated into two versions -the friendly missile and enemy missile- that keep on developing independently from one another because they are self-organized. Taylor's test is applicable here in the sense that the higher the number of message interpretations, the higher the level of entropy or uncertainty for the message to be interpreted as the sender intended to. Guber's thesis can also be applied: the more innovative, entropic, unbelievable and unusual the rumor content, the more interesting for the recipients and the higher the connectivity in the system.

Second and third order changes greatly influence the transmission chain feedback, since individuals, when in doubt about the truthfulness of the first version, are willing to retransmit the rumor but using the second version. Consequently, the transmission rate increases because there are more versions of the rumor in the street and it can be transmitted more than once by the same individual, in completely different versions, however. Under this circumstance the threshold is reduced because "if everybody speaks about it, somehow it must be true". Transitively, this, in turn, has an impact as feedback on the transmission system. This is when the system goes towards the edge of chaos: we do not understand what will happen due to the high level of uncertainty derived from the confusion of the different rumor contents. We only know that something interesting will occur.

When the distortion process continues and the bifurcations of content occur (the theory of the friendly missile, the enemy missile, the bomb, the faulty gate, the UFO, etc.) and the parameter reaches 3.7 (Feigenbaum point), total chaos takes place. The infinite number of choices result in a state where freedom is meaningless, i.e. the magnitude of perturbation creates such a generalized disadjustment that the number of circulating rumors generate collective panic and there is nobody and nothing worthy of credibility. It is perceived that something has occurred, but -due to the high level of uncertainty- nothing is certain. In this case the system is chaotic because the individuals' behavior becomes totally unpredictable. In these circumstances the population's threshold and the disbelief level increase because everything and everybody are the object of doubts.

Remember that the systems sensitive to initial conditions -those with a chaos potential- do not always exhibit a chaotic change. It becomes chaotic only when small errors, differences or initial inaccuracies are present.

To summarize: when a rumor is transmitted dissipatively in different versions, it does not necessarily become chaotic as it passes on from person to person. It does so when its content exhibits an initial succession of bifurcations, i.e. a change that determines a totally

new interpretation, a radical second and third order change exceeding the Feigenbaum Point, to the extent that at a certain moment we do not know what to believe in.

In connection with the analysis of rumor attractors, we have shown that the individuals' personality and state of the mind greatly influence the decision as to rumor acceptance, diffusion or rejection. In fact, the rumor-related behavior becomes more complex and, as seen before, it can change itself and self-organize as the individuals' behavior towards a specific rumor mixes with the behavior of others.
This determines the system to be potentially chaotic due to its sensitive dependence on initial conditions. Given certain small changes in key parameters, a group of individuals of the same universe with a similar personality, status and socialization will spread a rumor while another will not. Both behaviors result from the same butterfly attractor formed by two tori. Each of them is a basin of qualitatively different results for very similar systems. These similar systems will have different destinations depending on their path through uncertainty.
In this process the individual's belief system is essential, i.e. the rigid structures of thought in his mind, because they are the basis of the decision-making process and they imply the difference between two individuals of similar characteristics which will determine changes in the initial condition. Therefore, the belief systems are so relevant because they are strong rumor attractors. We have seen that both prejudices and conspiracy theories, although not exclusive, are two examples of belief systems that function as powerful rumor attractors.

As Moran has shown, in mental processes it is possible to find patterns that repeat continuously, not periodically but as strange attractors. These strange attractors are very complex and only a small portion of each is likely to be very active, i.e. in the individual's mind only one part of the attractor is likely to be frequently visited by the dynamical system solution seeker, while the others are ignored. In pathological cases, we would say that they are fixed ideas to which the individual's mind resorts to with insistence – recurrent ideas within which everything is associated according to the sick individual.

In the case of prejudices, we say that they are not only strong rumor attractors, but also the ideal culture broth for their generation. This is so due to the existent tendency in people to forecast the environment development in order to control it and thus lower the uncertainty level that affects them. This desire and determination to forecast what will happen also comprise the desire to predict the others' behavior. As there is no basic difference between how individuals perceive objects, things and people, behavior forecasting supposes the functional linking of facts. Humans are self-conceived as causants and this leads us to the irrestrictive desire of determining and controlling our own behavior. This experience is projected to the behavior of others, i.e. we generalize and attribute our own experiential relationships to others in their subjective combination of cause and effect. The concrete result is that each individual constantly seeks the cause, the reason for the behavior of others in order to be able to forecast it and thus control it. Therefore, it is clear that naive behavior lies in judgements based on deficient data, i.e. prejudices. Thus, prejudices constitute a belief system useful to orient and regulate our behavior.
An event deemed important makes individuals feel the need to know all its details; if deprived of information, they show anxiety. Uncertainty generates anxiety and when it grows, resistance gets lower and people are ready to believe anything because the threshold drops. It is the culture broth for rumor. When a rumor finally starts to circulate, the level of credibility assigned to it by us is much higher: we agree on its truthfulness

because it is shared and therefore, believable. On the other hand, since prejudices are shared, within the framework of our own group of belonging, we are naturally prone to sharing those facts based on rumors. Nothing is more attractive than sharing a "juicy" rumor with friends who think like us.

Conspiracy theories are associated with prejudices. They are to be interpreted in terms of the two extremes these meanings are usually associated with: a collective "paranoia" and irrationality of low cultural population segments. In other words, they are built upon pre-conceived ideas, i.e. prejudices. Within this framework, conspiracy theories, or more adequately, "conspiracism" can no longer be considered a marginal phenomenon of psychologically perturbed groups. The growth of the collective dimension of this "paranoia", from the Cold War in the 60's, suggests that the belief in conspiracies can be a symptom but not of an illness.
Goertzel showed that the conspiracy theories system is relatively rigid because it is subject to change, but only within certain restricted boundaries. It is therefore a strange attractor. Although Goertzel has not been able to show that it results in a chaotic attractor, he strongly suspects that there is a high likelihood for chaos to exist as long as specific beliefs and strengths fluctuate pseudo randomly while the structure of the conspiracy belief as such remains the same.

Summary: in the light of the theory of complexity and chaos, we can now define rumor as a social emergent of sudden manifestation, of novel nature and of unpredictable evolution in its future behavior. As a communication system it has the following characteristics: it is complex, non-linear (feedback), dissipative (it is transmitted along an increasingly complex chain of connections), entropic (as it flows, uncertainty grows) and self-organizing (its content is re-generated in new and different ways to that of the original). In certain cases it can even be chaotic (when, after several bifurcations, the system's degrees of freedom are so wide that the result is completely unpredictable) and of fractal structure (when it develops an identical transmission morphology in different population scales).

Beyond Allport y Postman's formula, completed by Chorus, R = f(A.I.1/c) -the circulating quantity of rumor is a function of the product of the importance of its content multiplied by the ambiguity surrounding the overall situation multiplied by the inverse of the sensitivity or critical standpoint of every individual to whom the rumor is transmitted. The more relevant system's control parameters result from the degree of uncertainty and Granovetter's threshold (the number of individuals of the recipient's group of belonging that must accept the rumor for the individual to accept it, considering the pondering process made by the recipient).

Finally, rumor content can be controlled by one or several strange attractors (in which all the points of the system's trajectory are subject to change, within restrained boundaries), that determine the message's morphology. These strange attractors are formed by belief systems, fixed in the mind of rumor generators or transmitters; these individuals are also responsible for conspiracy theories derived from unusual events such as the case of the unresolved assassination of a public figure.

As mentioned in the prolog of this work, some researchers have concluded that the complexity and chaos theories represent an alternative vision regarding the prevailing scientific discourse because, rather than focusing on the predictability of phenomena based on linear relations, it allows the holistic analysis of the evolution of complex systems

using the methodology of the non-linear dynamical systems theory. This is what this work has intended to show through a very peculiar system of social communication: the rumor. We have had a critical attitude in the hope that it may become an interesting starting point for later analysis and studies.

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Born six decades ago in the field of meteorology, cultivated in the field of physics and developed by modern mathematics, the theory of complexity chaos is the study of behavior and its patterns in complex, non-linear and systems. The analysis of rumor in the light of this theory offers a new perspective on this social little studied phenomenon.

This work states the fact that by studying rumor as a dynamical non system, its analysis cannot be separated from its diffusion process, its speech-related process and from the psychosocial characteristics of the actors involved. Rumor transmission and content, environmental circumstances and the individuals' profile influence each other in this highly complex system in which everything is connected to everything.

Two highly attractive approaches are provided by cellular automata and the theory of percolation; these areas are the subject of scientific research in the field of artificial and are widely used in the study of disease spreading, a phenomenon that shows similarities to that of rumor.

As per rumor content, one of the most interesting aspects of the theory of chaos is involved: the concept of "attractor". It is therefore essential to analyze the individual's belief system, i.e., the rigid structures of thoughts occurring in his mind, since they are the basis of the decision making process, and they make the difference between two individuals of similar characteristics. The analysis of two belief systems, prejudices and conspiracy theories in this work suggests that they can be powerful attractors of rumor, which establish -with a high degree of probability- certain patterns in its rumor content.

There is no doubt that the new paradigm of complexity and chaos represents an alternative vision regarding the scientific content prevailing in the rumor. Instead of focusing on lineal relations of its causes (psychology) or its effects (sociology), it enables the analysis of this phenomenon and social emergent in a holistic manner,
using the methodology of the theory of dynamical non linear systems.